SR5500

Wireless Channel Emulator

User Manual

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Safety Summary

If the equipment is used in a manner not specified by the manufacturer the protection provided by the equipment may be impaired.

Safety Symbols

The following safety symbols are used throughout this manual and may be found on the instrument. Familiarize yourself with each symbol and its meaning before operating this instrument.

Instruction manual symbol. The product is marked with this symbol when it is necessary for you to refer to the instruction manual to protect against damage to the instrument.

Frame terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.

Protective ground (earth) terminal. Used to identify any terminal which is intended for connection to an external protective conductor for protection against electrical shock in case of a fault, or to the terminal of a protective ground (earth) electrode.

The caution sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product or your data.

Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).

Alternating current (power line).

Résumé des règles de sécurité

Si le matériel est utilisé d'une façon non conforme aux spécifications du constructeur, la protection assurée par le matériel peut être mise en défaut.

Symboles de sécurité

Les symboles suivants sont utilisés dans tout le manuel et peuvent être trouvés sur le matériel. Il est recommandé de se familiariser avec chaque symbole et sa signification avant de manipuler le matériel.

Symbole « manuel d'instruction ». Ce symbole apparaît sur le produit lorsqu'il est nécessaire de se référer au manuel d'instruction pour éviter une détérioration du matériel.

Masse. Ce symbole identifie une connexion au châssis du matériel (ce châssis inclut normalement toutes les structures métalliques exposées).

Terre : ce symbole identifie la connexion de terre chargée de protéger le matériel contre les chocs électriques. Cette connexion doit être raccordée vers un conducteur externe de protection ou vers une électrode de type terre.

Caution

Ce symbole désigne une opération ou une condition dite « sensible », qui, si elle n'est pas correctement réalisée, pourrait entraîner de sérieuses détériorations au matériel ou aux données utilisateur.

Ce symbole indique un voltage dangereux (connexion alimentée en interne par un voltage excédant 1000 volts).

Courant alternatif (ligne de puissance).

Table of Contents

1. Introduction 1

1.1. Overview 1

1.2. SR5500 Applications 3

1.2.1. Applicable to All Design Phases 3

1.2.2. Evaluating Radio Access Technologies 5

1.2.3. Evaluating Air Interface Performance 5

1.3. Key Product Features 6

1.3.1. Wireless Channel Emulation Features 6

1.3.2. Ease-of-Use Features 6

1.4. SR5500 Guided Tour 7

1.4.1. Front Panel Description 7

1.4.2. Rear Panel Description 9

1.5. Quick Start Procedure 12

1.6. Verification Procedure 15

1.7. Quick Start Using Test Assistant 17

1.8. Version History 20

2. Operation Reference 25

2.1. Overview 25

2.2. Operational Overview 25

2.2.1. Connecting to the SR5500 26

2.2.2. Basic Operation 27

2.3. Channel Modes 33

2.3.1. Single Channel Mode 33

2.3.2. Dual Channel Mode 33

2.3.3. RX Diversity Mode 34

2.3.4. TX Diversity Mode 34

2.3.5. 2x2 MIMO Mode 34

2.3.6. 4x4 MIMO Mode 35

2.3.7. Bi-directional 2x2 MIMO System Mode 35

2.4. Using the Test Assistant 36

2.4.1. Accessing the Test Assistant 36
2.4.2. Changing the Carrier Frequency 36
2.4.3. Automatically Selecting a Channel Profile 37
2.4.4. Completing the Configuration 37
2.5. Channel Player 38
2.6. File Operations 40
2.6.1. Settings Saved in the Settings File 40
2.6.2. Load PDP From File 41
2.6.3. STX Files 41
2.6.4. Recent File List 41
2.7. Operational Detail 41
2.7.1. Channel I/O Parameters 41
2.7.2. Path Parameters 61
2.7.3. Sum of Sinusoids Mode 70
2.7.4. Interference 81
2.7.5. Instrument Setup View 84
2.7.6. Summary View 88
2.7.7. SR5078 Switch Control 92
2.7.8. Bi-Directional 2X2 MIMO 92
2.8. Dynamic Environment Emulation 96
2.8.1. Method 97
2.8.2. Emulation File Creation (DEE Template) 98
2.8.3. Dynamic Environment Emulation (DEE) View 106
2.8.4. Using DEE with Multiple SR5500s 111
2.8.5. Dynamic Correlation in DEE 111
2.8.6. Sum Of Sinusoids (SOS) DEE 116
2.9. Fading Lab 118
2.9.1. Method 119
2.9.2. Fading Data Playback File Creation 119
2.9.3. Fading Lab View 122
2.9.4. Using Fading Data Playback with Multiple SR5500s 124
2.10. Using the SR5500 with 6 GHz/6GHz-EX Option 124
2.10.1. Configuring TestKit for the 6 GHz(-EX) Option 124
2.10.2. Selecting Lower/Middle/Upper Band 124
2.10.3. Parameter Dependencies 126

2.11. Downloading Firmware to the SR5500 126
2.11.1. Starting the Download 126
2.11.2. During the Download 127
2.11.3. Recovery in Case of Failure 127
2.12. Changing the Remote Connection 127
2.12.1. Changing the SR5500 IP Address Configuration 128
2.12.2. Changing the IP Address in SR5500 TestKit 130
2.13. Updating the SR5500 Options 131
2.14. Controlling Multiple SR5500 Units 132
2.14.1. Connecting Synchronization Cables 132
2.14.2. Unidirectional 4x4 MIMO 133
2.14.3. Fading Data Playback Setup 134
2.14.4. Configuring TestKit to Control Multiple Units 136
2.14.5. Switching between Units 138
2.14.6. Player Functionality 138
2.14.7. Correlation Coefficient Type 139
2.14.8. System-Based Correlation 140
3. Technical Reference 142
3.1. Overview 142
3.2. Radio Channel Power Delay Profile 143
3.3. Static Relative Path Delay 144
3.4. Time-Varying Relative Path Delay 144
3.4.1. Sliding Relative Path Delay 145
3.4.2. Birth-Death Time-varying Relative Path Delay 146
3.5. Relative Path Loss 147
3.6. Fast Fading 147
3.6.1. Rayleigh Fading Amplitude Distribution 148
3.6.2. Rician Fading Amplitude Distribution 151
3.6.3. Fast Fading Power Spectrum Shapes 153
3.7. Static Amplitude Channel Effects 154
3.7.1. Frequency Shift (Static Doppler) 154
3.7.2. High Speed Train Frequency Shift 154
3.7.3. Static Phase Shift 155
3.8. Slow Shadow Fading 156

3.9. Additive White Gaussian Noise (AWGN) Interferer 158
3.10. Power Meter 163
4. Instrument API 166
4.1. Overview 166
4.2. Benefits and Features 167
4.3. Development Environments 167
4.4. API Usage Example 168
4.5. API Front Panel 169
4.5.1. Invoking the API Front Panel 169
4.5.2. The API Front Panel Window Components 170
4.6. Further Information 173
5. Remote Programming Interface Operation 174
5.1. Overview 174
5.2. Remote Control Features 174
5.3. Configuring SR5500 TestKit for Remote Control 175
5.3.1. Setting up the Remote Programming Interface 175
5.3.2. Start/Stop the Listener 177
5.3.3. Local/Remote Mode 177
5.3.4. Enable Monitor Messages 177
5.3.5. Enable TCP/IP Echo 177
5.3.6. Automatically Configuring SR5500 TestKit for Remote Control 177
5.4. SR5500 TestKit Command Protocol 178
5.4.1. Command Types 178
5.4.2. Command Sequence 178
5.4.3. Program Messages 179
5.4.4. Response Format 180
5.4.5. Long Form and Short Form of Mnemonics 180
5.4.6. Hierarchical Default Format 181
5.4.7. Error Message Format 181
5.5. Transmission Layer Protocols 182
5.5.1. LAN CR/LF Protocol 182
5.5.2. GPIB Protocol 182
6. RPI Command Reference 187

6.1. Overview 187
6.2. Conventions to Specify Commands 187
6.2.1. Command Summary 188
6.3. Command Descriptions 194
6.4. Command Dependencies 234
6.5. Autoset 236
6.6. Overload Status 236
6.7. Dynamic Environment Emulation (DEE) 236
6.8. Fading Playback 237
7. Technical Specifications 239
7.1. Overview 239
7.2. RF Channel Specifications 239
7.2.1. Input Signal Level 240
7.2.2. Output Signal Level 240
7.2.3. Channel Crest Factor 240
7.2.4. Spurious Emission Levels 240
7.2.5. Residual EVM 240
7.2.6. Noise Floor 241
7.2.7. RF Physical Interface Characteristics 241
7.3. RF Channel Specifications (with the SR5500 6 GHz Option)* 242
7.3.1. Input Signal Level 242
7.3.2. Output Signal Level 242
7.3.3. Channel Crest Factor 242
7.3.4. Spurious Emission Levels 243
7.3.5. RF Physical Interface Characteristics 243
7.4. RF Channel Specifications (with the SR5500 6 GHz-EX Option)* 243
7.4.1. Input Signal Level 243
7.4.2. Output Signal Level 244
7.4.3. Channel Crest Factor 244
7.4.4. Spurious Emission Levels 244
7.4.5. RF Physical Interface Characteristics 245
7.5. RF Channel Specifications (with the EOP 4GHz Hardware Option)* ... 245
7.5.1. Output Signal Level 245
7.5.2. Channel Crest Factor 246

7.6. Channel Emulation Characteristics 246
7.6.1. Number of Paths per Channel 246
7.6.2. Path Characteristics 246
7.6.3. Frequency Shift 247
7.6.4. Phase Shift 247
7.6.5. Path Loss Characteristics 247
7.6.6. Path Delay Characteristics 248
7.6.7. Path Fading Characteristics 248
7.6.8. Fading Power Spectrum 249
7.6.9. Rician Fading Characteristics 249
7.6.10. Log-Normal Fading Characteristics 249
7.6.11. Dynamic Environment Emulation (DEE) 250
7.6.12. Fading Playback 251
7.6.13. Multi Antenna 252
7.6.14. Path Rayleigh Fading Correlation 252
7.7. Interference Generation Characteristics 253
7.7.1. Interference Characteristics 253
7.7.2. AWGN Correlation 253
7.7.3. AWGN Performance 253
7.8. Power Measurement Characteristics 254
7.9. Interface and Environmental Characteristics 255
7.9.1. SR5500 Front Panel Indicators 255
7.9.2. SR5500 Power Requirements 255
7.9.3. 6GHz(-EX) Option Power Requirements 255
7.9.4. Operating Environment 255
7.9.5. SR5500 Dimensions and Weight 256
7.9.6. 6 GHz Option Dimensions and Weight 256
7.9.7. SR5500 Control Interfaces 256
7.9.8. 10 MHz Reference Requirements 256

1. Introduction

1.1. Overview

The Spirent SR5500 Wireless Channel Emulator accurately emulates complex wideband wireless channel characteristics such as time-varying multi-path delay spread, fading, and channel loss. By providing a programmable and repeatable set of emulated radio channel conditions, the SR5500 enables a thorough, structured approach to receiver performance characterization. There are two versions of the SR5500 hardware; the SR5500, and the SR5500M. The different versions are shown in Figure 1-2 and Figure 1-2 respectively. Other versions are described as SR5500 throughout the remainder of this manual, except where necessary.

The SR5500 replicates real-world deployment conditions using powerful digital signal processing techniques, making it possible to isolate performance issues early in the development and design verification cycle. Optional AWGN enhances the real-world conditions emulated by the SR5500. Early optimization of performance accelerates time to market and minimizes post-deployment issues.

Figure 1-1: SR5500 Wireless Channel Emulator

Figure 1-2: SR5500M Wireless Channel Emulator

Complete analysis of today's complex radio transmission schemes requires a channel simulator that offers rich emulation of radio channel characteristics. This is required to ensure that lab and field performance measurements align. At the same time, the instrument implementation must contribute minimal unwanted parasitic simulation effects that can distort test results. The SR5500 high performance, all-digital signal processing engine presents a realistic set of radio channel conditions to the most complex radio transmission technologies. The use of the SR5500 DEE (Dynamic Environment Emulation) further replicates real-world fading scenarios by allowing dynamic control over fading parameters. With high fidelity channel and long simulation repetition rates, the SR5500 ensures reliable and accurate performance evaluation.

The SR5500 Graphical User Interface (GUI) shown in Figure 1-3, enables you to select channel models from a vast library of pre-defined industry standard channel models, or custom configurations that provide extreme precision using the Channel Model Editor. Once the channel model is configured, the Channel Model Player enables low-level control over playback, including the ability to play, pause, and stop the simulation. If changes to the channel model are required, the SR5500 real-time fading sequence generation enables modifications to take effect instantly. This eliminates the need to tolerate the testing delays associated with fading simulators that must pre-calculate fading sequences.

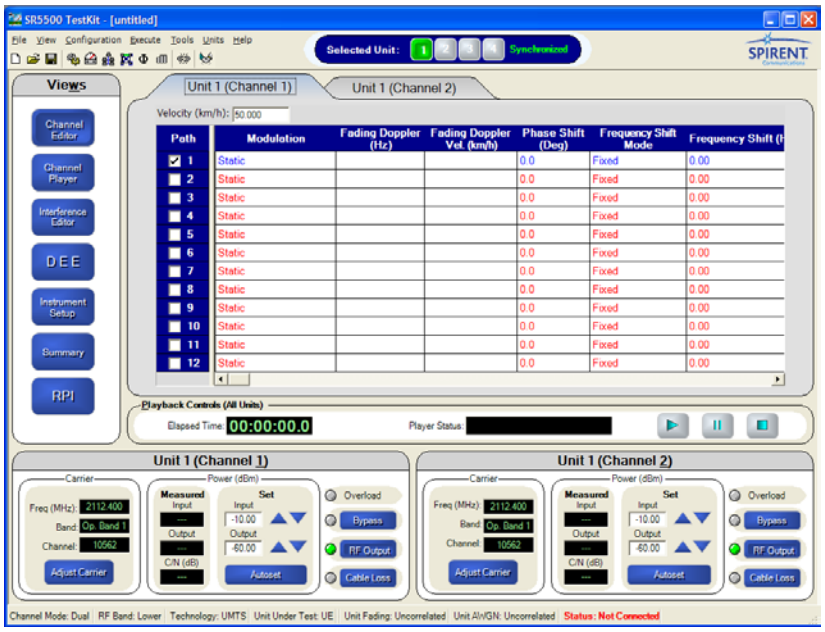


Figure 1-3: SR5500 Wireless Channel Emulator Graphical User Interface

With the standard instrument configuration equipped with 24 independent multi-paths, the SR5500 delivers performance evaluation beyond the minimum performance requirements associated with 3G technologies, such as CDMA2000 and WCDMA, and with evolving Wireless LAN standards. The SR5500 enables you to program time-varying channel conditions, which is a critical capability required to properly assess the overall performance of high-speed transmission technologies such as 1xEV-DO, 1xEV-DV, and WCDMA HSDPA that employ adaptive modulation and coding schemes.

1.2. SR5500 Applications

The SR5500 emulates a wide array of radio channel conditions ranging from indoor micro cellular environments with low mobility to macro-cellular environments with high-speed mobility. With a channel modeling engine capable of an assortment of configurations, the SR5500 can analyze the performance of current and emerging air interface technologies such as EDGE/GSM/GPRS, CDMA2000, WCDMA, 802.16, and 802.11a/b/g in representative deployment conditions without leaving the test lab. To facilitate testing that requires co-channel interference, the SR5500 optionally includes the ability to generate AWGN. The SR5500 can be utilized in both Handset and Base Station test applications, as shown in Figure 1-4 and Figure 1-5. These capabilities make it possible for the SR5500 to play a valuable role in all phases of the product realization cycle.

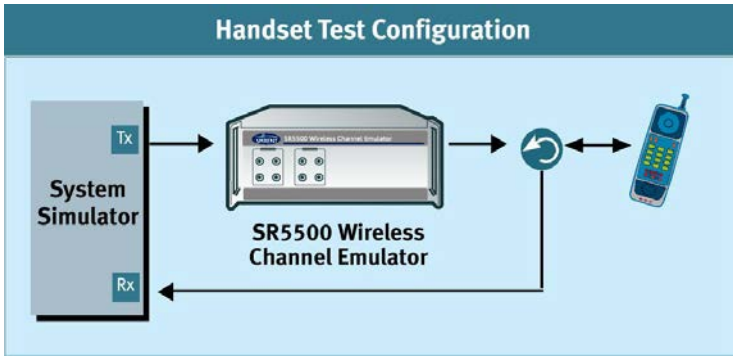


Figure 1-4: SR5500 Handset Test Setup

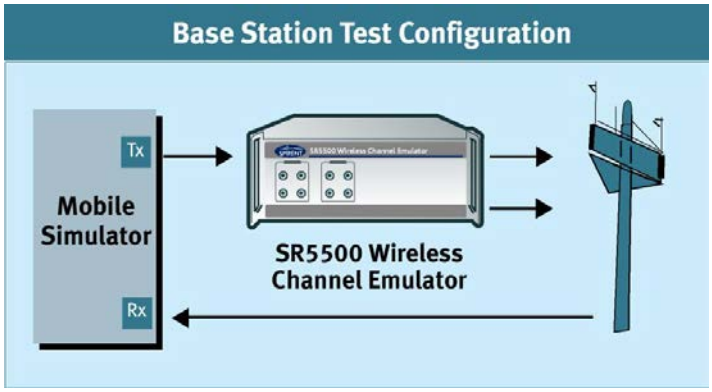


Figure 1-5: SR5500 Base Station Test Setup

1.2.1. Applicable to All Design Phases

Comprehensive performance evaluation throughout the product development cycle improves the probability of identifying potential design issues at a stage where they can be easily addressed. The SR5500 plays a valuable role throughout the product realization process.

1.2.1.1 Research and Development

Early in the design and standardization of new air interface technologies, physical layer modulation schemes, channel coding, and mobility algorithms must be evaluated and compared. The SR5500 can analyze the performance of competing technologies by providing repeatable test conditions across test campaigns. It is capable of sophisticated channel models, low signal distortion, and can accommodate the evaluation of next-generation, wide-bandwidth signal formats.

1.2.1.2 Design Verification Test

Comprehensive evaluation of reference designs and commercial products against original design objectives is a critical phase in the product realization process. You can configure the SR5500 to emulate a wide range of radio propagation environments with precise control over channel conditions for performance breakpoint analysis. With an easy-to-use software Application Programming Interface (API), the SR5500 easily integrates into automatic test systems capable of performing a large number of test cases in minimal time.

1.2.1.3 Acceptance/Conformance Test

Before deployment, commercial products must typically undergo a series of acceptance and conformance tests based on minimum industry performance standards. The SR5500 User Interface features a Test Assistant that makes it easy to emulate propagation conditions defined in various industry test specifications. These propagation conditions are defined by ETSI, 3GPP, 3GPP2, and ITU.

1.2.1.4 System Performance Test

Once deployed to the field, the performance of wireless equipment is analyzed and optimized. To accelerate the optimization process, it is necessary to recreate challenging field scenarios on a controlled, repeatable test bed. By utilizing both RF channels in the instrument, you can configure the SR5500 for bi-directional full duplex performance evaluation. You can also program the SR5500 to play back field conditions repeatedly, enabling the adjustment of algorithms until optimal performance is realized.

1.2.2. Evaluating Radio Access Technologies

The SR5500 possesses the capabilities necessary to evaluate a broad range of local and wide-area wireless network technologies. With frequency coverage up to 6 GHz, the SR5500 covers all deployment frequency bands.

Supported technologies include:

- GSM/GPRS/EDGE
- WCDMA
- WCDMA HSPA (HSDPA/HSUPA)
- HSPA+
- LTE
- CDMA2000 1x
- CDMA2000 1xEV-DO
- CDMA2000 1xEV-DV
- Location Based Services
- 802.11.a/b/g
- 802.16(WiMAX)
- HiperLAN

1.2.3. Evaluating Air Interface Performance

Radio access technologies possess layers of algorithms designed to mitigate the harsh effects of radio propagation and to deliver seamless mobility. The SR5500 possesses the critical features required to stress test air interface performance and to identify opportunities to improve product design. The SR5500 can be used to evaluate and improve the performance of:

- Baseband Demodulation.
- Rake Finger Tracking.
- Diversity Reception.
- Channel Equalization.
- Power Control Schemes.
- Handover Efficiency.
- Radio Link Protocols (RLPs).
- Geolocation.
- Multiple Input, Multiple Output (MIMO) Systems.

1.3. Key Product Features

1.3.1. Wireless Channel Emulation Features

With a powerful all-digital signal processing engine, the SR5500 emulates wideband channel conditions with unprecedented accuracy and programmability.

RF Channel Emulation features include:

- Comprehensive channel models with up to 24 independent paths enables evaluation of 3G and Wireless LAN equipment well beyond minimum performance standards.
- Real-time fading sequence generation enables channel model modifications without the lengthy delays required to pre-calculate fading coefficients.
- Superior channel fidelity required to properly evaluate higher-order modulation schemes, minimizing unwanted distortion that leads to false test results.
- Digital AWGN gives accurate and repeatable C/N, C/No, and Eb/No ratios.
- Creation of real-world fading scenarios with DEE (Dynamic Environment Emulation) enables time-vary fading parameters.
- Long fading sequence repetition rate ensures realistic test conditions results.
- Time-varying channel models include dynamic Power Delay Profiles that evaluate adaptive modulation and coding schemes.
- Real-time display of channel conditions and low-level control over channel model playback.
- Frequency range extends to 6 GHz to cover 802.11a applications.
- Power meter capable of both continuous and triggered mode, ideal for bursty signals like GSM/GPRS/EDGE and WLAN.
- Support for Multiple Input Multiple Output (MIMO) channel configurations.
- Support for Spatial Channel Models (SCM/SCME).
- Playback of data from real world measurements and call logs with Fading Lab.

1.3.2. Ease-of-Use Features

The SR5500 simplifies test setup and control with easy-to-use local and remote interfaces.

Some of these features include the ability to:

- Quickly recall industry standard fading profiles from 3GPP, 3GPP2, ITU and JTC.
- Create realistic user-defined scenarios using the SR5500 Channel Model Editor, providing easy access to emulation parameters.

- Set the absolute channel output level, without the need for external attenuators and calibration. This ensures accurate signal levels are always present at the receiver under test.
- Make real time changes to AWGN with the Interference Editor. This eliminates the need to re-configure the fading profile, significantly reducing test time.
- Monitor the Power Delay Profile and input/output power levels of the SR5500 in real-time. This provides valuable user feedback on current test conditions.
- Integrate the SR5500 into automatic test systems using a Windows .NET-based software API.

1.4. SR5500 Guided Tour

All SR5500 functionality is controlled through the instrument control software SR5500 TestKit or the Application Programming Interface (API). Refer to the Setup Guide included with the instrument for details on connecting the SR5500 system.

1.4.1. Front Panel Description

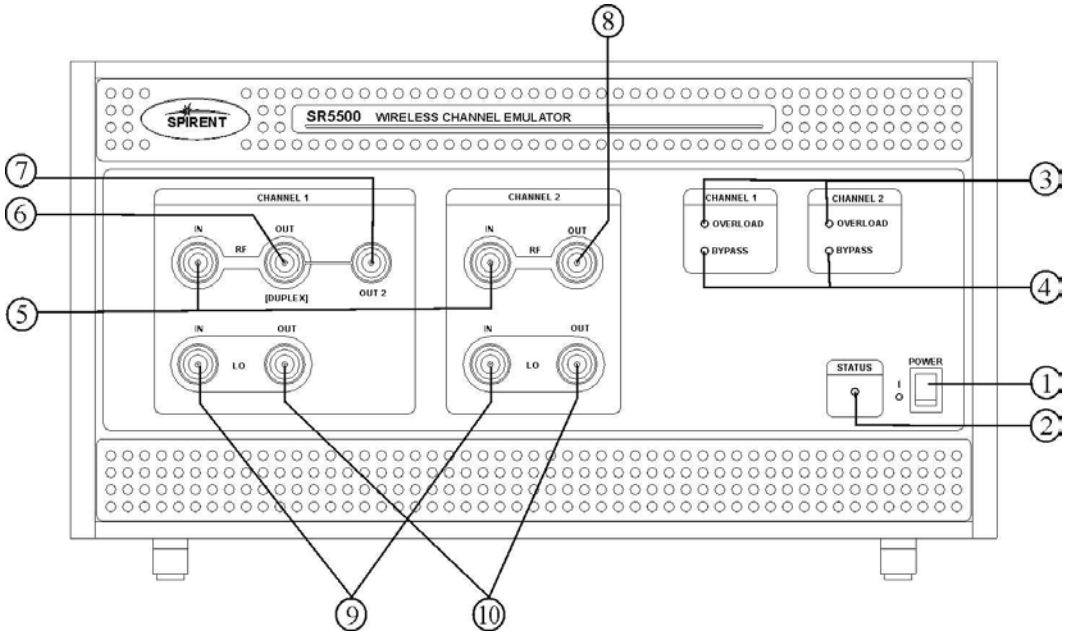


Figure 1-6: SR5500 Front Panel

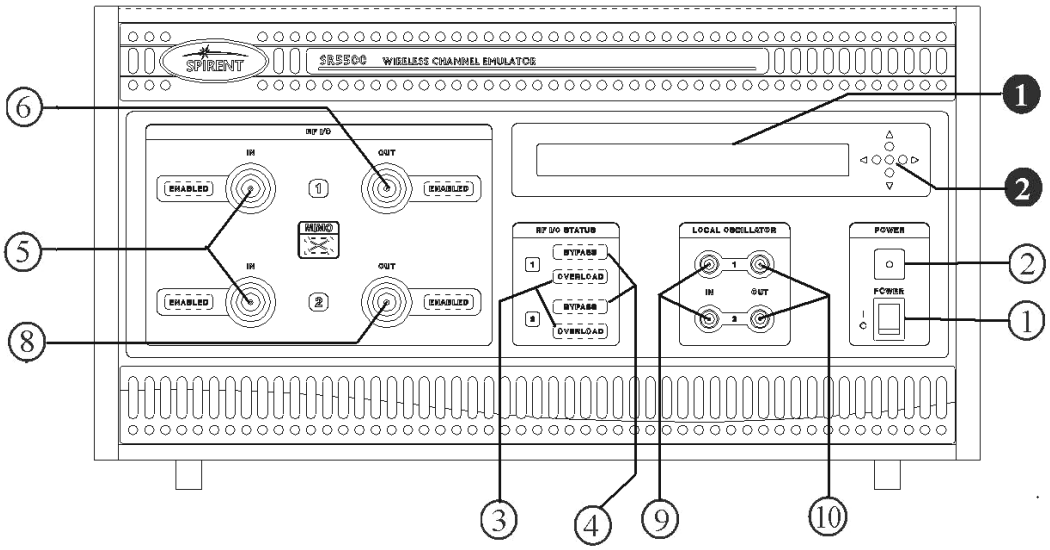


Figure 1-7: SR5500M Front Panel

Front Panel Control/Indicators	
①	**POWER Switch** The Power switch is located in the bottom right hand corner of the front panel.
②	**STATUS LED** The Status LED is located next to the power switch and indicates the current status of the unit. SR5500 is operating normally if the LED is green. An error condition exists when the STATUS LED is red. The LED takes a few seconds to illuminate during power up.
③	**CHANNEL 1 OVERLOAD LED and CHANNEL 2 OVERLOAD LED** The LED indicates the RF input signal has peak levels above the permitted range and will be clipped by the instruments input circuitry. The overload LED should be monitored to ensure the signal applied at the RF Channel input is within the specified range.
④	**CHANNEL 1 BYPASS LED and CHANNEL 2 BYPASS LED** This indicator tells whether the channel is in bypass mode. The channel is bypassed when the LED is green.

Front Panel Signal Input/Output Connectors	
⑤	**RF1 and RF2 IN** N Connector (50 Ω) - This connector functions as the channel RF input.
⑥	**RF1 OUT [DUPLEX on SR5500]** N Connector (50 Ω) - This connector functions as the channel 1 RF output.
⑦	**RF1 OUT [OUT2]** (Available on SR5500 Only) N Connector (50 Ω) - Reserved for future use.
⑧	**CHANNEL 2 RF OUT** N Connector (50 Ω) - This connector functions as the channel 2 RF output.
⑨	**RF1 and RF2 LO IN** This connector functions as the channel local oscillator input. LO IN must be connected to LO OUT via the Loop-back cable supplied with the SR5500.

Front Panel Signal Input/Output Connectors	
⑩	**RF1 and RF2 LO OUT** This connector functions as the channel local oscillator output. LO IN must be connected to LO OUT via the Loop-back cable supplied with the SR5500.
❶	**LCD DISPLAY (**Available on SR5500M Only**)** The LCD display is used to display SR5500 status information
❷	**MENU NAVIGATION KEYS** (Available on SR5500M Only) These keys are reserved for future use.

CAUTION: The RF IN and OUT Ports can accept a limited power range; refer to the technical specifications to ensure absolute maximum levels are not exceeded.

1.4.2. Rear Panel Description

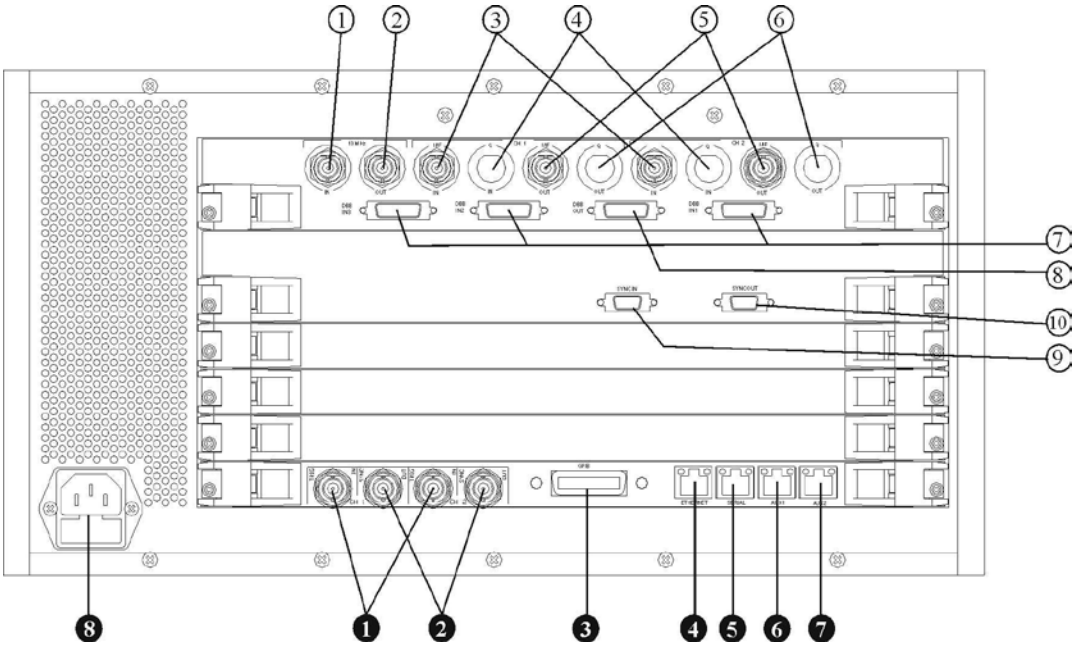


Figure 1-8: SR5500 Rear Panel

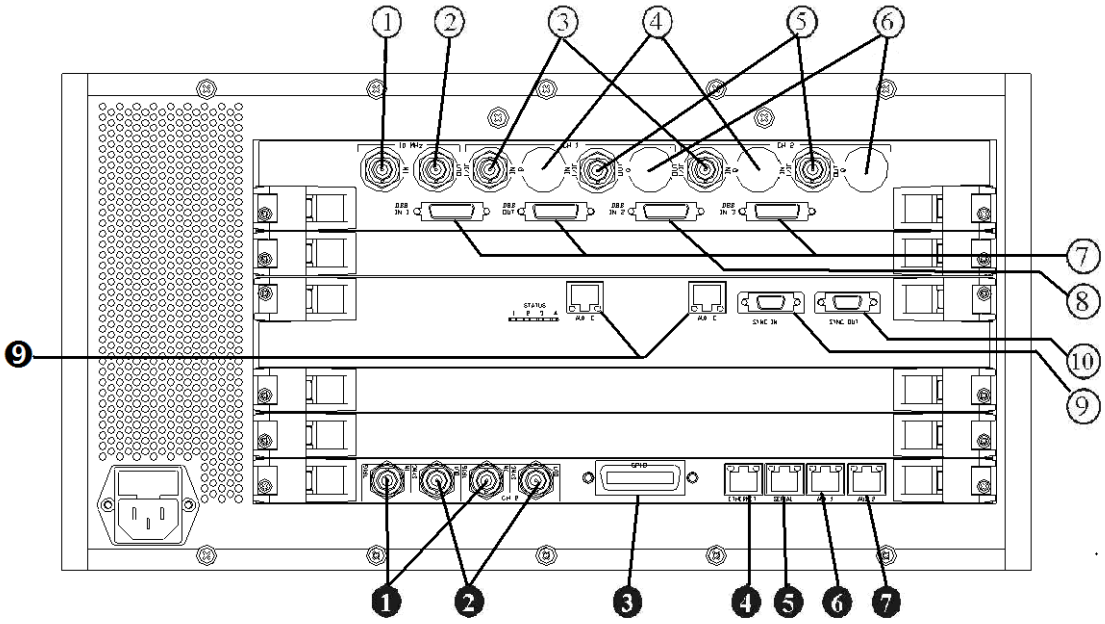


Figure 1-9: SR5500M Rear Panel

Rear Panel Controls	
①	**10 MHz IN** BNC Type Connector (50 Ω) - Accepts an externally supplied 10 MHz sine wave reference signal which can be used to drive the internal signal processing circuitry of the SR5500.
②	**10 MHz OUT** BNC Type Connector (50 Ω) - Provides a 10 MHz sine wave reference signal as an output.
③	**CH 1 and CH 2 I/IF IN** BNC Type Connector (50 Ω) - Reserved for future use.
④	**CH 1 and CH 2 Q IN** BNC Type Connector (50 Ω) - Reserved for future use.
⑤	**CH 1 and CH 2 I/IF OUT** BNC Type Connector (50 Ω) - Reserved for future use.
⑥	**CH 1 and CH2 Q OUT** BNC Type Connector (50 Ω) - Reserved for future use.
⑦	**DBB IN1, IN2, and IN3** 26 Pin MDR Type Connector DBB IN1 - Used to transfer data from one 4x4 MIMO unit to another DBB IN2, IN3 - Reserved for future use.
⑧	**DBB OUT** 26 Pin MDR Type Connector - Used to transfer data from one 4x4 MIMO unit to another.
⑨	**SYNC IN** 15 Pin MDR Type Connector - Used to synchronize fading data between multiple SR5500 systems.
⑩	**SYNC OUT** 15 Pin MDR Type Connector - Used to synchronize fading data between multiple SR5500 systems.

Rear Panel Controls	
❶	**CH 1 and CH 2 TRIG IN** BNC Type Connector (50 Ω) CH1 TRIG IN - Used to trigger DEE CH2 TRIG IN - Reserved for future use.
❷	**CH 1 and CH 2 SYNC OUT** BNC Type Connector (50 Ω) - Reserved for future use.
❸	**GPIB** Reserved for future use.
❹	**ETHERNET** RJ-45 Type Connector - The Ethernet port supports TCP/IP. It is recommended that a Category 5 Ethernet cable be used.
❺	**SERIAL** RJ-45 Type Connector - Control port used exclusively for configuring Ethernet communication parameters.
❻	**AUX 1** RJ-45 Type Connector - This port is used to control the SR5500 6 GHz(-EX) RF Converter.
❼	**AUX 2** RJ-45 Type Connector - Reserved for future use.
❽	**AC Power Receptacle** The AC universal power receptacle is located on the lower left corner of the rear panel. This receptacle also contains the fuses for the unit.
❾	**AUX-S and AUX-E** (Available on SR5500M Only) RJ-45 Type Connectors AUX-E - Used to download data to the unit for Fading Data Playback. AUX-S - Reserved for future use.

1.5. Quick Start Procedure

To prepare the SR5500 for initial operation, perform the following steps. Refer to the table below to determine the number of cartons in the SR5500 shipment.

1. Unpack the SR5500 shipping cartons. There should be two shipping cartons, one containing the SR5500 and accessories and the other containing the PC. An optional third carton contains the SR5500 6 GHz(-EX) RF Converter and accessories.
   a. The cartons should contain a packing list detailing all the items in the cartons.
   b. Make sure that all parts listed on the packing list are contained in your SR5500 shipping cartons.
   c. Save the shipping cartons and packing materials until you have completed the system installation and initial check. If you must return equipment, please use the original box and packing material.
   d. Check each item for physical damage. If any part appears to be damaged, contact the Spirent Communications Customer Service department.
2. Plug one end of the supplied AC power cord into the rear panel, and plug the other end into your AC source. Repeat as necessary.
3. Connect supplied loop-back cables from LO IN CH1 to LO OUT CH1. Repeat for LO CH2.
4. **OPTIONAL:** Connect the following cables between the SR5500 and the SR5500 6 GHz(-EX) RF Converter.

(From) SR5500	(To) 6 GHz(-EX) RF Converter	Cable Used
CHANNEL 1 RF IN	IF - CH1 OUT	Supplied N-N cable
CHANNEL 1 RF OUT	IF - CH1 IN	Supplied N-N cable
CHANNEL 2 RF IN	IF - CH2 OUT	Supplied N-N cable
CHANNEL 2 RF OUT	IF - CH2 IN	Supplied N-N cable
AUX 1	(Unlabeled RJ-45 connector on rear panel)	RJ-45 Cable

5. **OPTIONAL**: A Serial cable (**RJ-45 Type** connector to **DB-9 Type** connector) can be used to change the IP address of the SR5500 or send a password to upgrade the options available on the unit.
   a. Connect the Serial cable (supplied) to the port labeled 'SERIAL' on the rear panel of the SR5500 and the other end to the serial port on the controller laptop.
   b. If the controller laptop doesn't have a serial port, use a USB to serial converter (supplied) to connect the laptop to the SR5500's serial cable.
   c. Plug the USB to Serial converter into the bottom USB port on the right panel of the laptop, as shown in Figure 1-10 and Figure 1-11.

NOTE: The USB to Serial converter should be plugged in only into the indicated USB port

Figure 1-10: USB Port used for a USB to Serial Converter

Figure 1-11: USB Port used for USB to Serial Converter – Side View

d. The SR5500 controller laptop should have the necessary drivers for the converter pre-installed. For a laptop without the drivers, please use the driver CD shipped along with the USB to Serial converter.

e. Connect the other end of the USB to Serial converter to the SR5500's Serial cable.

6. Connect the supplied cross over cable from the PC built-in Ethernet port (not the PC Card Ethernet Port), to the SR5500 Ethernet port on the rear panel. Optionally, you can connect the PC Card Ethernet Port to the LAN.

NOTE: When connecting the 6 GHz (EX) RF connector to the SR5500 the supplied N, N cables must be used in order to maintain level accuracy.

7. Turn the power on.

   a. Set the AC power switch on the lower right corner of the front panel to the "|" position. The SR5500 now executes its power-up self-test and calibration sequence, this takes a few seconds. You will hear two beeps and the status light will illuminate green.
   Note: *The STATUS Light will take a few seconds before turning on.*

   b. **OPTIONAL:** If the SR5500 6 GHz(-EX) RF Converter is present, turn the power on by setting the AC power switch to the "|" position on the rear of the unit.

   c. Power on the PC. Refer to the PC documentation for details.

8. Launch the instrument control software SR5500 TestKit on the PC by clicking the **TestKit** icon on the desktop. After launching the SR5500 TestKit application, complete the connection to the SR5500 by clicking the **Connect** icon shown in Figure 1-12.

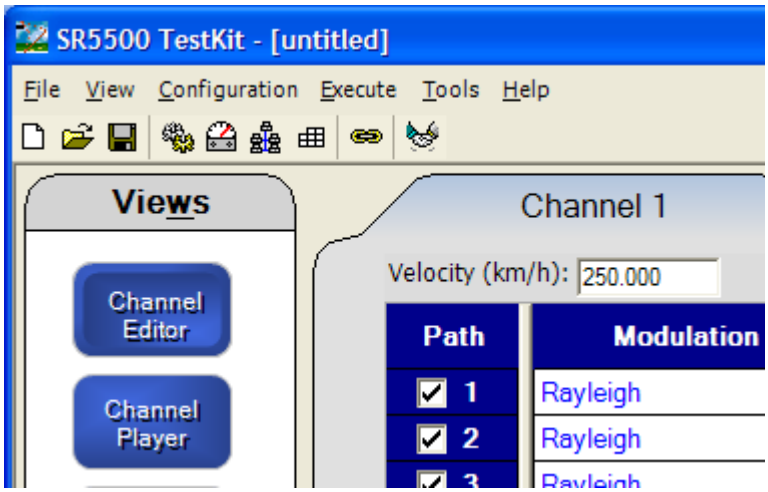


Figure 1-12: SR5500 TestKit Software Menus

9. TestKit indicates the connected status by displaying *Status: Connected* in the status bar at the bottom of the window, as shown in Figure 1-13.

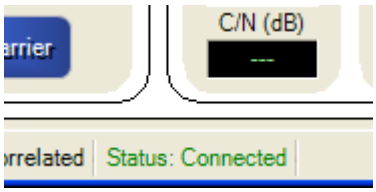


Figure 1-13: Status Connected Indicator

NOTE: Non-US Keyboards are not supported, though Non-US English is supported by SR5500 TestKit.

Currently, Remote desktop is not supported.

1.6. Verification Procedure

This procedure verifies the basic operation of the SR5500. It is not necessary to complete these steps to use the SR5500. A signal generator and spectrum analyzer capable of operating at 900 MHz is needed for this verification. The SR5500 default settings are used for this procedure. Use the following table and block diagram to connect the required equipment.

Connect From	Connect To	Cable
Signal Generator Output	SR5500 CHANNEL 1 RF IN	N to N
SR5500 CHANNEL 1 RF OUT	Spectrum Analyzer Input	N to N

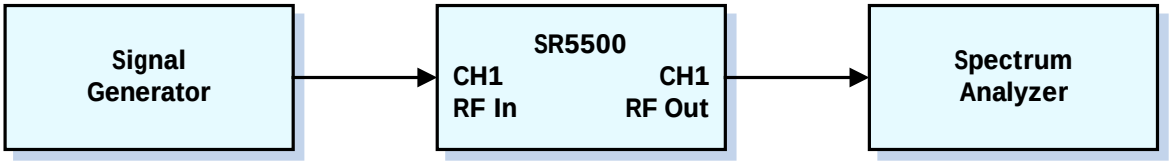


Figure 1-14: SR5500 Verification Setup Diagram

OPTIONAL: Use the table and block diagram shown in Figure 1-15 to connect the equipment to a SR5500 equipped with the 6 GHz(EX) RF Converter.

Connector 1 (From)	Connector 2 (To)	Cable
Signal Generator Output	SR5500 6 GHz(-EX) RF Converter CH 1 RF IN	N-Type
SR5500 6 GHz(-EX) RF Converter CH 1 RF OUT	Spectrum Analyzer Input	N-Type

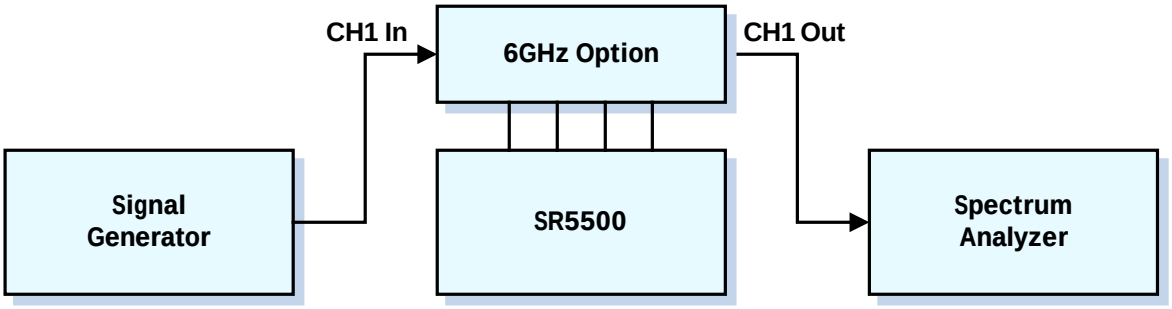


Figure 1-15: SR5500 with 6GHz (-EX) Option Verification Setup

To run the Verification Procedure:

1. Follow the procedure to connect the instrument with TestKit, outlined in Section 1.5. on page 12.
2. Select **File>Open Settings File**, as shown in Figure 1-16.

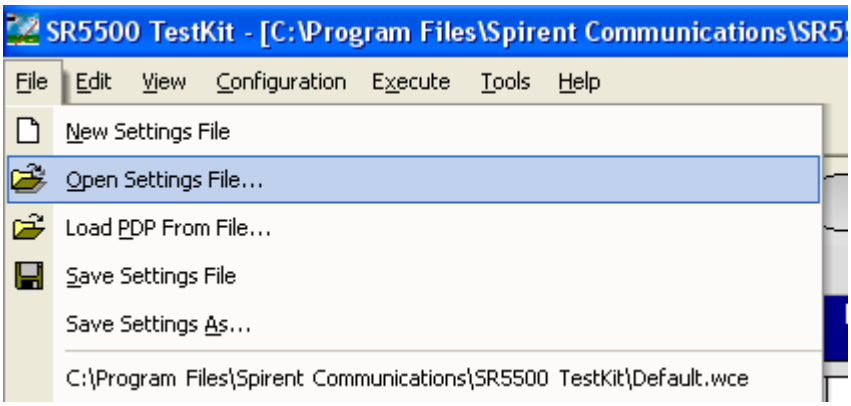


Figure 1-16: SR5500 TestKit – Open Settings File

3. Open the c:\Program Files\Spirent Communications\SR5500 Testkit\Default.wce settings file.
4. Set the signal generator to **900 MHz** with an output power of **-10 dBm**.
5. Set the spectrum analyzer to **900 MHz** with a span of **30 MHz**.
6. The output signal should be about **-60 dBm**, as shown in Figure 1-17.

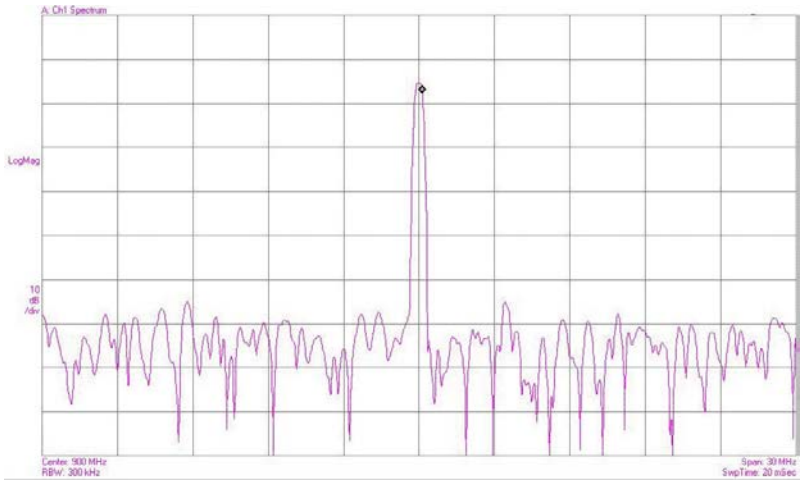


Figure 1-17: Spectrum Analyzer Output Signal of SR5500 at 900 MHz

1.7. Quick Start Using Test Assistant

This procedure uses the Test Assistant to step through an example of a GSM standard Specification Test. Test Assistant automatically configures the SR5500 for the specific test application.

A Base Station Emulator, circulator, and a DUT (GSM Mobile) are used for this procedure. Figure 1-18 shows the setup for the Mobile Test.

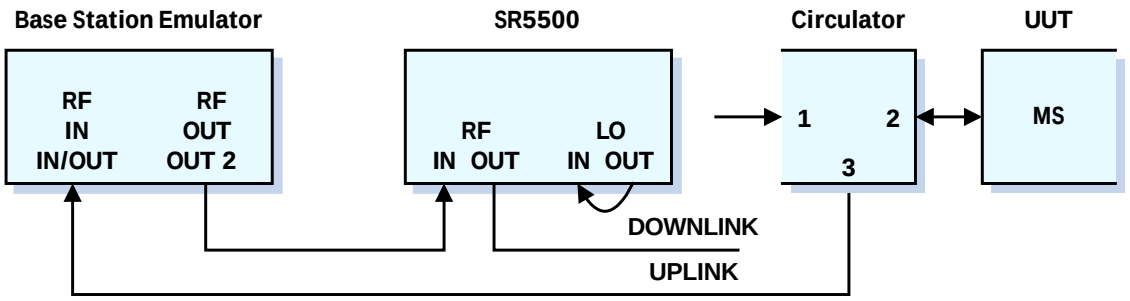


Figure 1-18: Mobile Test Setup

1. Connect the Base Station Emulator **RF Output Port** to the **Channel 1 RF IN** of the SR5500 with the appropriate cable.
2. From **Channel 1 RF OUT** on the SR5500 connect to **Port 1** of a Circulator, using the appropriate cable.
3. Connect **Port 2** of the circulator to the **Antenna Port** of the GSM DUT (mobile phone for this example). This completes the required connections for the downlink path (Base Station to Mobile Station).
4. Connect **Port 3** of the Circulator to the **RF Input Port** of the Base Station Emulator. This connection establishes the unimpaired uplink path (Mobile Station to Base Station).

5. After completing the interconnections outlined in Figure 1-18, power-on all instruments in the test setup.
   Before proceeding with the Test Assistant configuration, ensure the SR5500 TestKit is running and connected to the SR5500.

6. Click the **Test Assistant** icon located on the toolbar of SR5500 TestKit.
   The *Test Assistant* window displays, as shown in Figure 1-19.

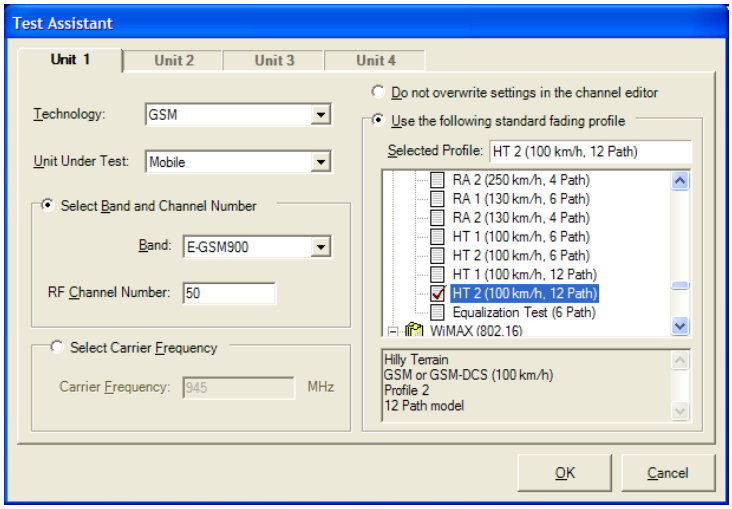


Figure 1-19: Test Assistant Window

7. Set the following parameters:
   a. Set *Technology* to **GSM**.
   b. Set *Unit Under Test* to **Mobile**.
   c. Set *Band* to **E-GSM900**.
   d. Set Channel Number to **50**.

8. Select **Use the following standard fading profile**, as shown in Figure 1-20.

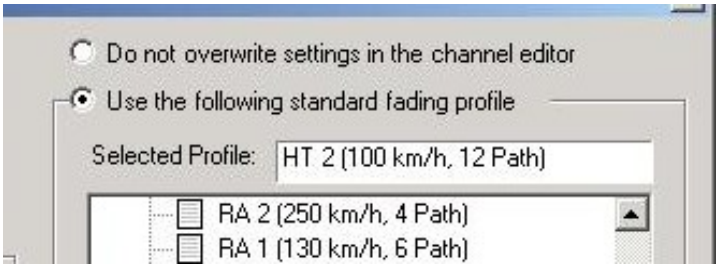

Do not overwrite settings in the channel editor
Use the following standard fading profile
Selected Profile:
HT 2 (100 km/h, 12 Path)
RA 2 (250 km/h, 4 Path)
RA 1 (130 km/h, 6 Path)

Figure 1-20: Test Assistant Window – Profile Selection Option

9. Select the **HT2 (100 km/h, 12 path)** model from the profile list.

10. Click the **OK** button.
    The Channel Editor is now set to the test case *Hilly Terrain 12 path model* used for 3GPP test standards.

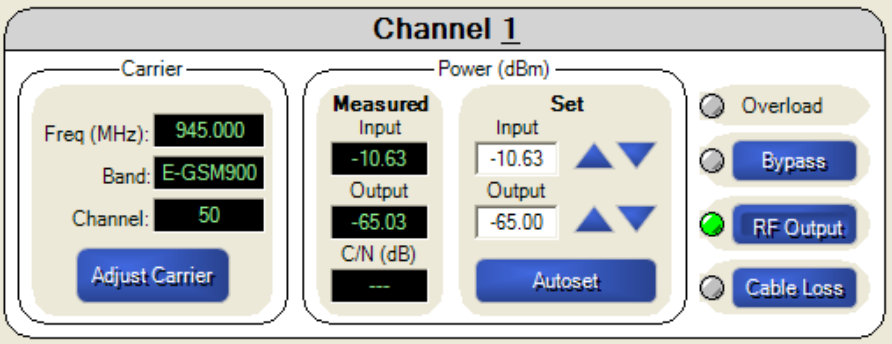


Figure 1-21: Sample Channel Editor with Correct Values Entered

11. Set the Base Station Emulator Output Power to **-10 dBm**.
12. Program the *Output Level* to **-65 dBm**, as shown in Figure 1-22.

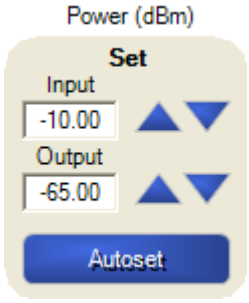


Figure 1-22: Output Level Meter

13. Click the **Autoset** button in the *Channel Editor*, as shown in Figure 1-23.

Figure 1-23: The Autoset Button

14. Click the **Channel Player** icon to get a channel representation of the fading profile generated by the SR5500, as shown in Figure 1-24.

Figure 1-24: The Channel Player Button

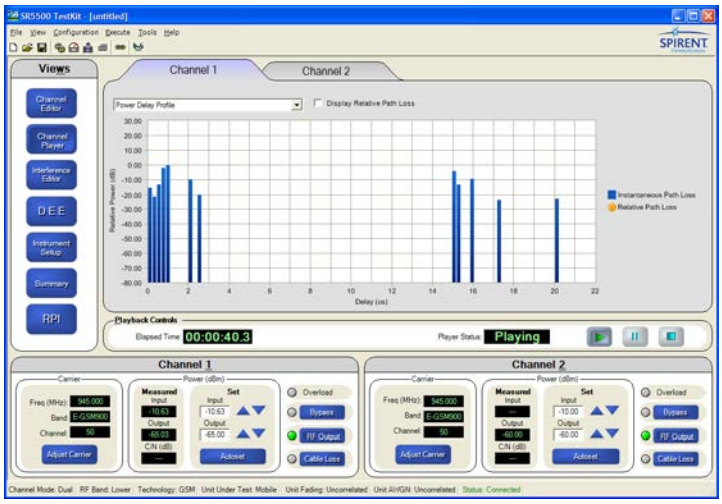


Figure 1-25: Sample TestKit Window

15. Click the **Play** button to start the Fading Emulation.
    You are now ready to perform a Mobile Performance Test.

1.8. Version History

The following information provides a summary of feature releases for the SR55500 since the version 2.00 release. To upgrade to a particular version, the SR5500 instrument Annual Service Agreement (ASA) expiration date must be later than or equal to the release ASA date. To verify the ASA expiration date, refer to Section 2.12 on page 130.

Version 3.50

- Added support for Bi-Direction MIMO 8x2.
- Antenna polarization support in MIMO 2x2 GCM Mode.
- File recall of PDP parameters.
- Support for VDT-CT files.

Version 3.40 (Release ASA DATE: JUNE 2010)

- Added support for Bi-Directional MIMO 4X4.
- Added support for MIMO 4X4 in the 3.3-3.85 MHz band.
- Added Global Overload Indicator.
- Added full support for Bi-Directional MIMO 2X2 in the Test Assistant
- Enhanced DEE to play for a specified number of loops.
- Enhanced DEE to play at a specific system time.
- Added a Global Power Meter Display which brings all power related settings and information for the system in one global view.
- Added the ability to export DEE states to the template.

Version 3.30 (Release ASA DATE: NOVEMBER 2009)

- Added native support for SCM/SCME/WINNER though SR5500 real-time engine
- Added support for time varying dynamic Geometric Channel Models (e.g. SCM/SCME/WINNER) parameters in Dynamic Environment Emulation (DEE) real-time engine
- Added support for time varying dynamic Complex Correlation matrices in Dynamic Environment Emulation DEE real time engine
- Added integrated FDD/TDD Bi-Directional 2X2 MIMO configuration setup for enhanced ease through a single screen
- Support for high-order bidirectional MIMO configurations in a single fully synchronized system through an intergraded RF Interface (RFI) separable hardware.
- External the RF Interface (RFI) hardware.
- Redefined Player "Stop" in MIMO 2X2 to Quad-Hybrid mode to achieve the maximum throughput in stop mode.
- Added support for Bypass during File Recall to maintain the call connectivity between different profiles
- Support for the new 3GPP LTE MIMO channel model correlations in Test Assistant

Version 3.20 (Release ASA DATE: FEBRAUARY 2009)

- Added support for Extended Output Power
- Added support for EOP 4GHz Hardware module
- Added support for Fading Lab
- Added support for SCM/SCME
- Added support for Bypass during DEE Disable
- Added support for the LTE Moving Propagation conditions.

Version 3.12 (Release ASA DATE: AUGUST 2008)

- Resolved an issue with Automatic Phase Calibration.
- Added a command line switch, "-NL", to disable file logging.

Version 3.11 (Release ASA DATE: AUGUST 2008)

- Added support for 4x4 MIMO.
- Added support for DEE in 2x2 MIMO Mode.
- Added support for MIMO parameters in DEE.
- Added support for the 3GPP High Speed Train Model.
- Added support for Triggered DEE,
- Added the ability to perform Automatic Phase Calibration.
- Added the ability to modify the phase for the MIMO sub-channels.
- Added support for LTE fading profiles.
- Added enhanced support for the LCD panel.
- Resolved an issue with the delay uncertainty on power up.

Version 3.01 (Release ASA DATE: NOVEMBER 2007)

- Added support for legacy SR5500 hardware. The software now supports both the SR5500 and the SR5500M hardware.
- Added Support for detection and control of the SR5078 Test Switch hardware.
- Resolved an issue where the AWGN generator would fail to start when the system was powered on when extremely cold (‹0C).
- Resolved an issue where the output power was above expected when the fading player was stopped, the unit was in MIMO mode, and Log Normal Fading was enabled. All three conditions needed to exist for this issue to present itself.

Version 3.00 (Release ASA DATE: NOVEMBER 2007)

- Added support for the SR5500M Hardware platform.

NOTE: Version 3.0 of the system software only supports SR5500M hardware. It does NOT support legacy (SR5500) hardware. Users of the SR5500 should use either Version 2.30, Version 3.01, or greater of the TestKit software.

- Added support for the MIMO option.
- Added the ability to tune the phase of the RF Inputs and Outputs.

Version 2.30 (Release ASA DATE: MAY 2007)

- Added the ability to set Complex Correlation between any two channels located in different SR5500 systems. In addition, a unique Complex Correlation value can be specified between each corresponding path between the two channels.
- Added the ability to change C/N, and Doppler Velocity Parameters within DEE.
- Added the latest frequency bands, channels, and fading profiles specified in 3GPP TS 25.101 Release 6 and 7.

Version 2.21 (Release ASA DATE: DECEMBER 2006)

- Resolved an issue in RPI mode that caused DEE to fail unless DEE had been run manually at least once since power-up of the SR5500.

Version 2.20 (Release ASA DATE: DECEMBER 2006)

- Added the Remote Programming Interface view. This allows for remote control of the TestKit application via either the TCP/IP protocol or GPIB.
- Added the ability to change Angle of Arrival, K-Factor, and Frequency Shift Parameters within DEE.
- Added the ability to control multiple SR5500's with the SR5500-6GHZ-EX option simultaneously.
- Added the ability to turn the RF Output on or off with a single command.
- Resolved an issue that caused AWGN not to function properly with some hardware.

Version 2.10 (Release ASA DATE: APRIL 2006)

- Added ability to set Rayleigh fading correlation between channels located in different SR5500 systems.
- Added support for the SR5500-6GHZ-EX option which adds the 3300-3850 MHz Band.
- Added a "summary screen" to TestKit which allows you to view all configured paths in up to four systems simultaneously.
- Added the ability to connect to up to four SR5500 units simultaneously in an unsynchronized manner.
- Extended the C/N ratio available when the channel Crest Factor is set to a non-default value or when Log-Normal is enabled.

- Significantly increased the speed of DEE compilation by changing the format of the source file from an XML based file (SSX) to a raw text file (STB).
- Resolved an issue that prevented the SR5500 from being controlled across a network router.

Version 2.01 (Release ASA DATE: AUGUST 2005)

- Resolved an issue where, in some cases, noise could be produced at the SR5500 output port when no input signal was presented at the input port. This could also have occurred during the OFF time of a non-continuous signal.

Version 2.00 (Release ASA DATE: AUGUST 2005)

- Added support for control of up to four SR5500 units from a single TestKit GUI.
- Increased accuracy of output Power Meter when noise is enabled.
- Added real time C/N measurement to main window.
- Added settable duty cycle to Power Meter parameters.
- Increased allowable number of averages on Power Meter.
- Resolved issue with Test Assistant CDMA2K Fading Profile 5, where paths were being set to Rayleigh instead of static.
- Added 802.16(WiMAX) Models to the Test Assistant.
- Added “Round 12dB” Doppler shape for 802.16(WIMAX) testing.
- Increased resolution of Rayleigh Doppler velocity and frequency to accommodate 802.16(WIMAX) testing.

2. Operation Reference

2.1. Overview

SR5500 TestKit is a PC-based Graphical User Interface (GUI) for the configuration and control of the SR5500. TestKit runs under the Microsoft Windows operating system, delivering the same ease-of-use and GUI features that Windows provides. These features make it easy to use the SR5500 test system to perform sophisticated tests in a wide range of communication environments.

NOTE: SR5500 TestKit has already been installed on the PC that accompanies the SR5500.

- Although SR5500 TestKit is already installed on the accompanying PC, an SR5500 TestKit Install CD is included in the Manual binder. Use this CD to reinstall the application on the provided PC, if needed.

This section describes the basic operations of SR5500 TestKit. For more detailed information about the features, refer to Chapter Three on page 142.

NOTE: TestKit first starts in Local Mode and does not control the SR5500. Refer to Section 2.2.1 on page 26 for more information.

NOTE: The SR5500 features a powerful Player function that allows greater control over the fading emulation. The Player defaults to the Stopped position. To enable the channel emulation, click the Play button in the Player controls.

2.2. Operational Overview

To start SR5500 TestKit from the Windows Start Menu, click the **SR5500 TestKit icon**. You can also start SR5500 TestKit by clicking the program icon on the Windows desktop .

The *SR5500 TestKit Main Window* displays, as shown in Figure 2-1.

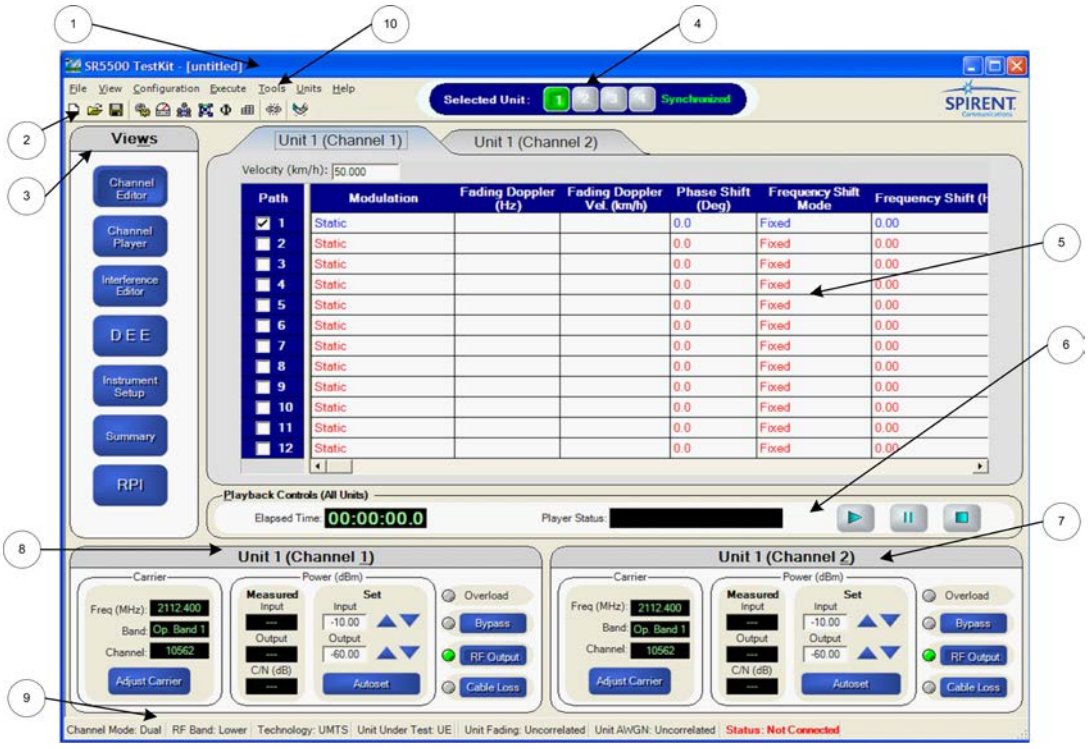


Figure 2-1: TestKit Main Window

The table below indicates the different parts of the TestKit Graphical User Interface (GUI).

①	Title Bar	⑥	Player Controls and Indicators
②	Tool Bar	⑦	Channel 2 I/O Controls and Indicators
③	View Controls	⑧	Channel 1 I/O Controls and Indicators
④	Unit Selection	⑨	Status Bar
⑤	View Area	⑩	Menu Bar

2.2.1. Connecting to the SR5500

SR5500 TestKit can operate in Local Mode or Remote Mode. In Local Mode, TestKit does not communicate with the SR5500. It emulates the control of the SR5500 but does not send any commands and the actual configuration of the SR5500 is not known.

In Remote Mode, SR5500 TestKit sends commands to the SR5500 and receives status information back. The presentation in Remote Mode is an accurate representation of the configuration of the SR5500. TestKit starts in Local Mode, and must be manually set-up to act in Remote Mode. There are two indicators of the Mode TestKit is in. The status bar on the bottom of the window indicates *Not Connected* or *Connected*, respectively. The Status Indicators are shown in Figure 2-2.

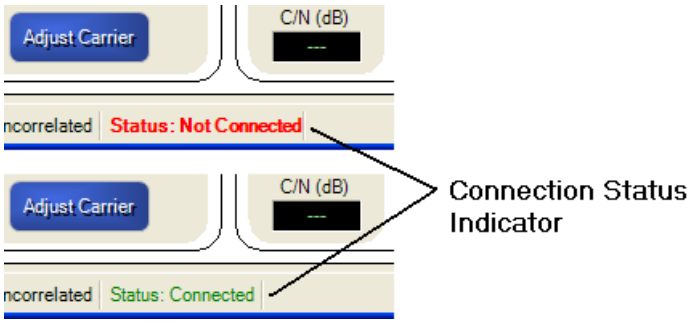


Figure 2-2: Connection Status Indicators

The icon on the tool bar changes appropriately to indicate the current status. In the *Execute* menu, the first item in the menu displays, "Disconnect from SR5500" while in Remote Mode.

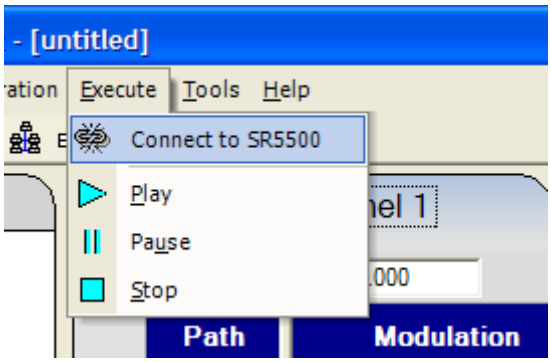


Figure 2-3: Execute Menu – Connect to SR5500

To enter Remote Mode, click the **Connect to SR5500** icon , or select **Execute›Connect to SR5500** as shown in Figure 2-3.

While establishing connection to the SR5500, TestKit attempts to communicate with the SR5500. If successful, it communicates with the SR5500 to synchronize the PC software and the SR5500 unit. If it is unsuccessful, you receive an error message indicating the problem.

2.2.2. Basic Operation

2.2.2.1 Title Bar

The Title Bar, shown in Figure 2-4, displays at the top of the window. It contains the program name and the name of the current settings file. After starting SR5500 TestKit, the current settings file is “[Untitled]”. The buttons at the right side of the Title Bar allow you to minimize, resize, or close the TestKit Application. The title bar also indicates the current view. For more details on the different views, refer to Section 2.2.2.4. on page 28.

Figure 2-4: TestKit – Sample Title Bar

2.2.2.2 Menu Bar

The Menu Bar, shown in Figure 2-5, is located immediately below the Title Bar. To display the items in that menu, click the menu name or hold down the **Alt** and the underlined letter of the menu title. Each menu provides access to a certain type of functionality.

Figure 2-5: TestKit – Sample Menu Bar

2.2.2.3 Toolbar

The Toolbar, shown in Figure 2-6, is located beneath the Menu Bar. The Toolbar provides quick access to commonly used functions.

Figure 2-6: TestKit – Sample Toolbar

	New Settings File - Resets all settings to the default values.
	Open Settings File - Loads the settings previously saved in a file.
	Save Settings File - Saves the current settings to the current file. If the settings have not yet been saved to a file, you will be prompted to specify a file name and location.
	Copies DEE State Information to the Windows Clipboard which can be pasted into a row in the DEE Template.
	Displays the *System/Communication Setup* Window.
	Displays the *Power Meter Parameters* Window.
	Displays the *Remote Programming Interface (RPI) Setup* Window.
	Displays the *Correlation Coefficient* Window.
	Displays the *Phase Calibration* Window.
	Indicates the connection status with the SR5500 unit, and triggers the opposite status when clicked.
	Displays the *Table Format* Window.
	Displays the Test Assistant Window.

2.2.2.4 View Area

The contents of the View Area can be changed to provide access to different functionality. Select the contents of the View Area by clicking the **View** buttons, or by making a selection from the View menu. An example of the View Area is shown in Figure 2-7.

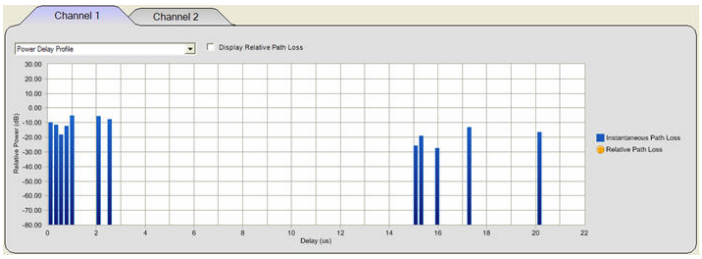


Figure 2-7: TestKit – Sample View Area

2.2.2.5 View Controls

The View Controls change the contents of the View Area. Different views provide access to different functionality. The View buttons work the same as selecting the item from the View menu. A sample View Control area is shown in Figure 2-8.

Figure 2-8: TestKit – Sample View Controls

2.2.2.6 Player Controls and Indicators

The Player Controls and Indicators allow control over the powerful Fading Data Playback engine. For a given set of profile conditions, the engine will always generate the same fading sequence. A sample Player Control Bar is shown in Figure 2-9.

Figure 2-9: TestKit – Sample Player Control Bar

You can control the fading emulation playback status with the Player Controls similar to the way you use the controls on a CD player. Observe the current point in the fading sequence via the Elapsed Time indicator.

Use the **Play** button to cause the fading emulation playback to proceed. Use the **Stop** button to stop the fading emulation playback and reset the Elapsed Time to zero. Use the **Pause** button to temporarily suspend the fading emulation playback. While paused, use the **Play** button to resume emulation playback.

While stopped or paused, the SR5500 does not vary the signal passing through it. The signal is subjected to the exact fading conditions at the moment indicated by the Elapsed Time indicator.

While stopped, the fading channel behaves as if a single path were enabled with no modulation. The delay of this path matches what is set for Path 1 of the particular channel. The following table describes the state of the instrument when stopped, for the various channel modes.

Channel Mode	INPUT	OUTPUT	STATUS
SINGLE CHANNEL MODE	1	1	Connected with a single path enabled
	1	2	No connection
	2	1	No connection
	2	2	RF Bypass Enabled
DUAL CHANNEL MODE	1	1	Connected with a single path enabled
	1	2	No connection
	2	1	No connection
	2	2	Connected with a single path enabled
TX DIVERSITY MODE	1	1	Connected with a single path enabled
	1	2	No connection
	2	1	No connection
	2	2	No connection
RX DIVERSITY MODE	1	1	Connected with a single path enabled
	1	2	Connected with a single path enabled
	2	1	No connection
	2	2	No connection
2x2 MIMO MODE	1	1	Connected with a single path enabled
	1	2	Connected with a single path enabled with a Phase Shift of 90 degrees
	2	1	Connected with a

Channel Mode	INPUT	OUTPUT	STATUS
			single path enabled with a Phase Shift of 90 degrees
	2	2	Connected with a single path enabled
4x4 MIMO MODE	1	1	Connected with a single path enabled
	1	2	No connection
	1	3	No connection
	1	4	No connection
	2	1	No connection
	2	2	Connected with a single path enabled
	2	3	No connection
	2	4	No connection
	3	1	No connection
	3	2	No connection
	3	3	Connected with a single path enabled
	3	4	No connection
	4	1	No connection
	4	2	No connection
	4	3	No connection
	4	4	Connected with a single path enabled

NOTE: The SR5500 resets the Time Elapsed indicator to zero and continues to play when a parameter is changed during playback. The SR5500 resets the Time Elapsed indicator to zero and stops when a parameter is changed while paused. Additive impairments are unaffected by the Play, Stop, and Pause buttons.

NOTE: The player state does not affect the additive interferer state. If AWGN is enabled, it is present even if the player is stopped.

2.2.2.7 I/O Controls and Indicators

Below the Player Controls and Indicators are the I/O Controls and Indicators. The Carrier Frequency Control and Indicators are on the left. The current carrier frequency is shown, as is the current Band and Channel for the selected Technology and Unit Under Test. Refer to Section 2.6. on page 41 for details on controlling the Carrier Frequency, Band, Channel, Technology and the Unit Under Test.

To the right of the Carrier frequency are the Power Controls and Indicators. Refer to Section 2.6.1. on page 41 for details on controlling the input and output powers.

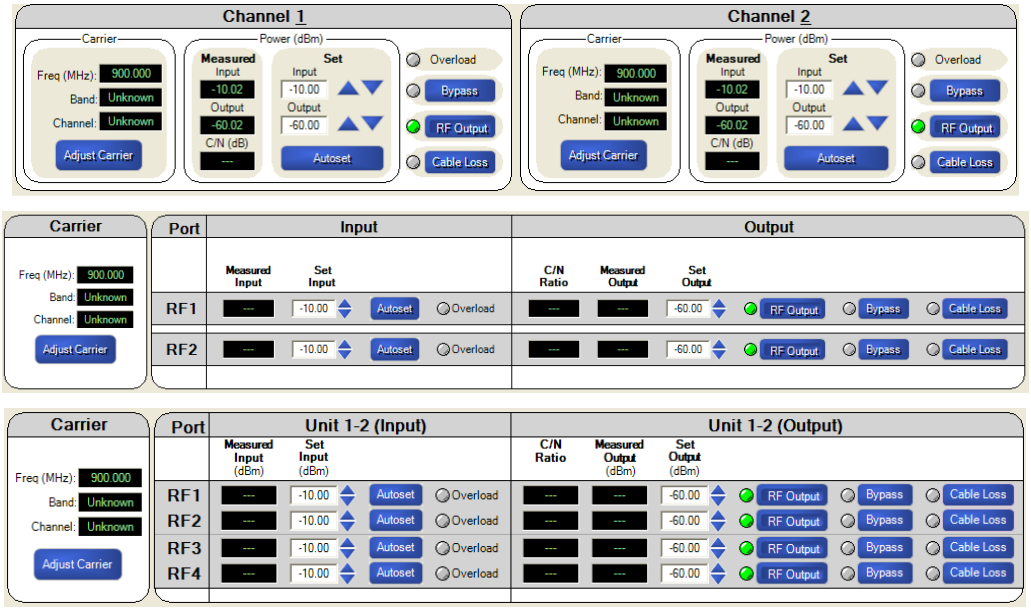


Figure 2-10: TestKit – Sample Dual Channel Controls (Top), 2x2 MIMO Controls(Middle) and 4x4 MIMO Controls (Bottom)

2.2.2.8 Status Bar

The status bar indicates the current settings for the following items:

- Channel Mode
- RF Band
- Technology
- Unit Under Test
- Unit/System Fading
- System Overload
- Remote Status
- Operation Progress

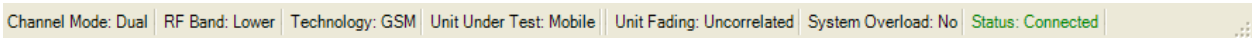


Figure 2-11: TestKit – Sample Status Bar

Refer to appropriate sections for more details on the above settings. The status bar also has an area to the right to indicate progress for actions that take more than a few seconds.

2.3. Channel Modes

The SR5500 has seven distinct channel modes that simulate different propagation effects. Set the channel mode in the *System Configuration* window, as described in Section 2.7.1.1 on page 41.

2.3.1. Single Channel Mode

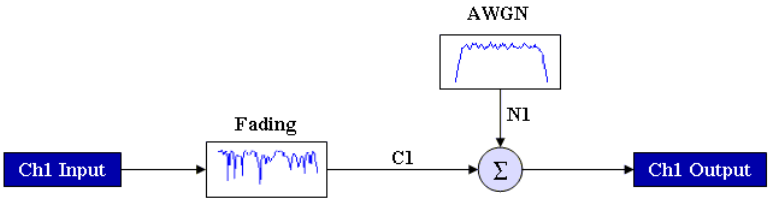


Figure 2-12: Single Channel Mode

Setting the Channel Configuration to **Single** provides a single Channel with 24 Paths. The other channel is automatically bypassed using the RF Bypass feature.

2.3.2. Dual Channel Mode

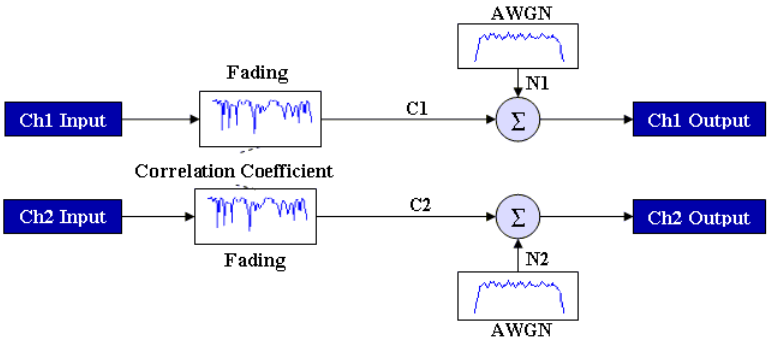


Figure 2-13: Dual Channel Mode

Setting the Channel Configuration to **Dual** provides two channels, each having 12 Paths.

2.3.3. RX Diversity Mode

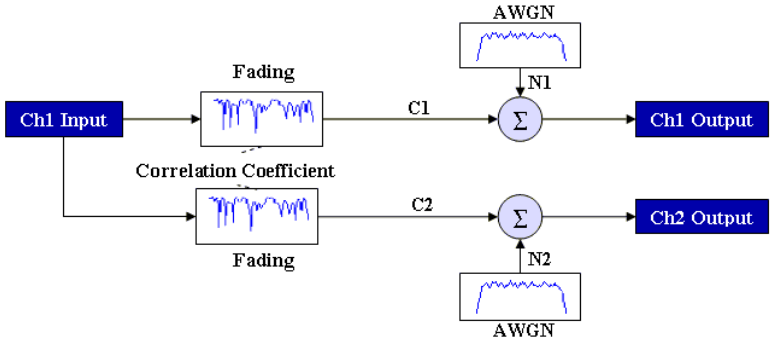


Figure 2-14: RX Diversity Channel Mode

Setting the Channel Configuration to **RX Diversity** provides two channels, each having 12 Paths. The input to RF port 1 is split out and distributed to both channels

2.3.4. TX Diversity Mode

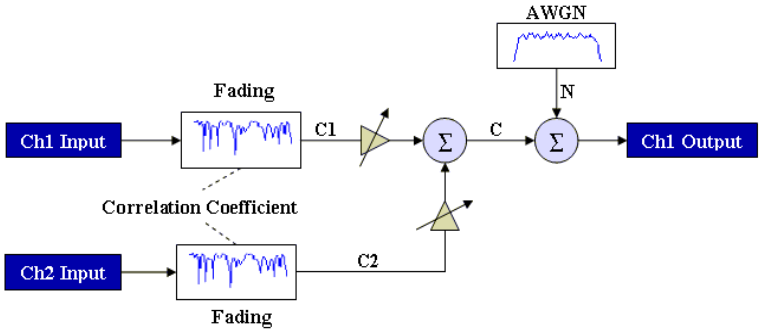


Figure 2-15: TX Diversity Channel Mode

Setting the Channel Configuration to **TX Diversity** provides two channels, each having 12 Paths. The inputs to both RF ports are faded and then summed together.

2.3.5. 2x2 MIMO Mode

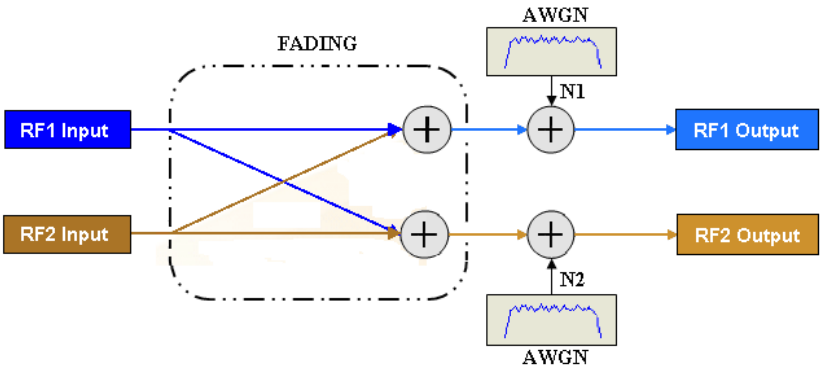


Figure 2-16:2x2 MIMO Channel Mode

Setting the Channel Configuration to 2x2 MIMO provides four sub-channels, each having 24 Paths. The inputs to both RF ports are faded and summed together, as shown in Figure 2-19. In 2x2 MIMO mode, each channel (h11,h21,h12,h22) has the same power delay profile as the other channel. This mode is available when the appropriate hardware and software options are installed.

2.3.6. 4x4 MIMO Mode

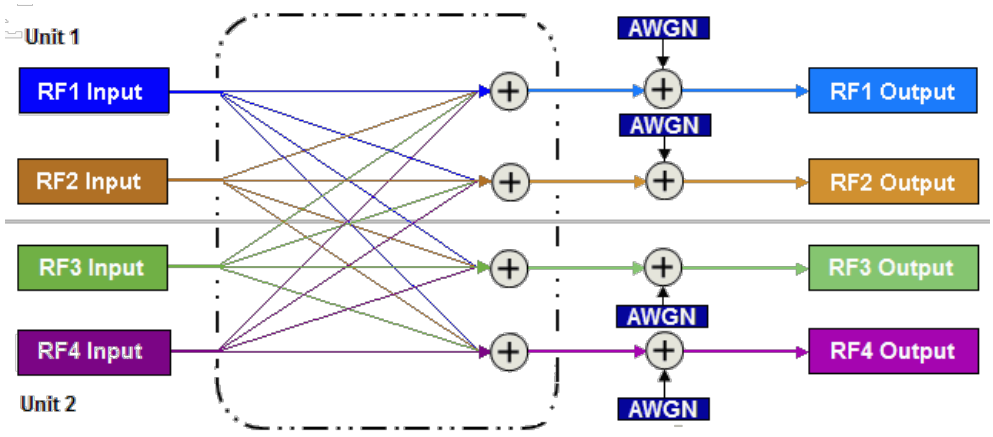


Figure 2-17:4x4 MIMO Channel Mode

Setting the Channel Configuration to 4x4 MIMO provides sixteen sub-channels, each having 24 Paths. The inputs to all four RF ports are faded and summed together, as shown in Figure 2-19. In 4x4 MIMO mode, all sub-channels (hij; i:1-4; j:1-4) have the same power delay profile. This mode is available when the appropriate hardware and software options are installed. Refer to Section 2.14 for more details on setting up a 4x4 setup.

2.3.7. Bi-directional 2x2 MIMO System Mode

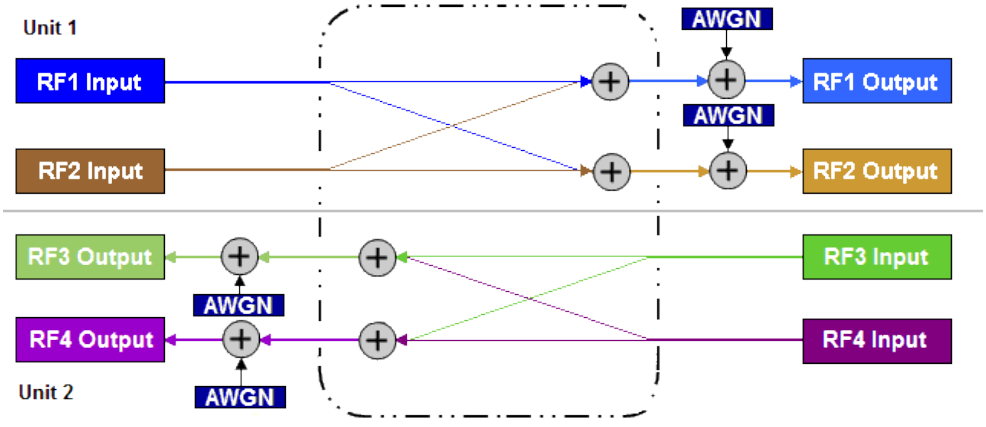


Figure 2-18: Bi-directional 2x2 MIMO Mode

Setting the System Mode to Bi-directional 2x2 MIMO configures two units with 2x2 MIMO channel configuration. Each unit will have the same power delay profile. This mode is available when the appropriate hardware and software options are installed. Refer to Section 2.7.8 for more details on setting up a Bi-directional 2x2 MIMO setup.

2.4. Using the Test Assistant

The Test Assistant is a powerful feature that simplifies setting up the SR5500 for tests based on industry standards.

2.4.1. Accessing the Test Assistant

To access the Test Assistant, select **Tools>Test Assistant**, or click the *Test Assistant* icon on the toolbar. The Test Assistant window displays as shown in Figure 2-19. For a detailed example on using the Test Assistant, refer to Section 1.5 on page 12.

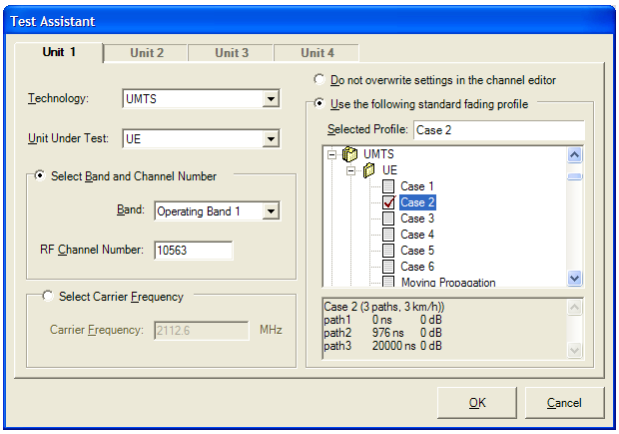


Figure 2-19: Test Assistant Window

2.4.2. Changing the Carrier Frequency

The Test Assistant allows you to enter the exact carrier frequency in MHz, or you can let the program set the carrier frequency based on the application. To set the carrier frequency directly, click the **Select Carrier Frequency** button. Enter the **Carrier Frequency** in MHz in the textbox as shown in Figure 2-20.

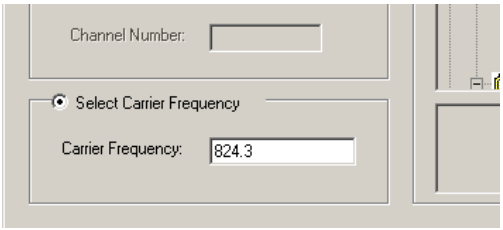


Figure 2-20: Select Carrier Frequency Button

To set the Carrier Frequency based on the application, select the appropriate Technology, then the Unit under Test. Next, click the **Select Band** and **Channel Number** button. Select the appropriate **Band** from the list box. Finally, enter the appropriate **Channel Number**. The Test Assistant uses these settings to calculate the Carrier Frequency. The Carrier Frequency appears below in the Carrier Frequency textbox.

2.4.3. Automatically Selecting a Channel Profile

The Test Assistant allows you to set the Fading Profile settings in the Channel Editor according to an industry standard. If the industry standard fading profile includes a path correlation component, it is also recalled.

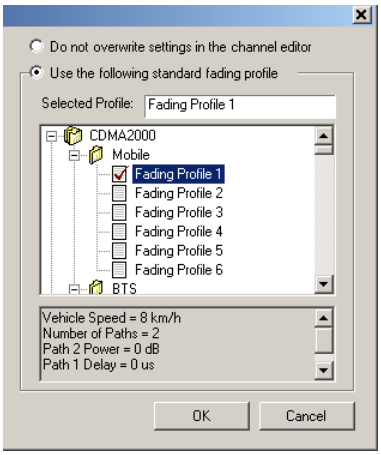


Figure 2-21: Test Assistant Channel Editor

If you want to leave the current settings in the Channel Editor, click the **Do not overwrite settings in the channel editor** button.

You are permitted to select a fading profile that does not match the Technology and Unit Under Test settings on the left. This flexibility allows you to apply any industry standard to the testing application.

Select a fading profile to view a textual summary. A textual summary displays in the textbox at the bottom of the window.

When you have made your final selections, click **OK** to apply your selections and close the *Test Assistant* window. If you want to cancel your selections, click **Cancel** to close the window.

2.4.4. Completing the Configuration

Although Test Assistant does most of the work, we recommend you set the output power and perform an Autoset. The SR5500 may not be properly configured for testing without completing these additional steps. For details on performing an Autoset and setting the output power, refer to Sections 2.6.1.4. and 2.6.1.5. on page 45.

NOTE: Selecting a Test Assistant configuration disables any Additive Impairments. If desired, the Additive Impairment can be enabled in the *View* window.

2.5. Channel Player

The Channel Player is a key feature of TestKit. This feature presents a graphical representation of the fading profile as it changes. To access the Channel Player, click the **Channel Player** button from the Views Panel. In non-MIMO modes, SR5500 TestKit displays a Channel Player similar to the display shown in Figure 2-22.

NOTE: This feature is not accessible when running DEE.

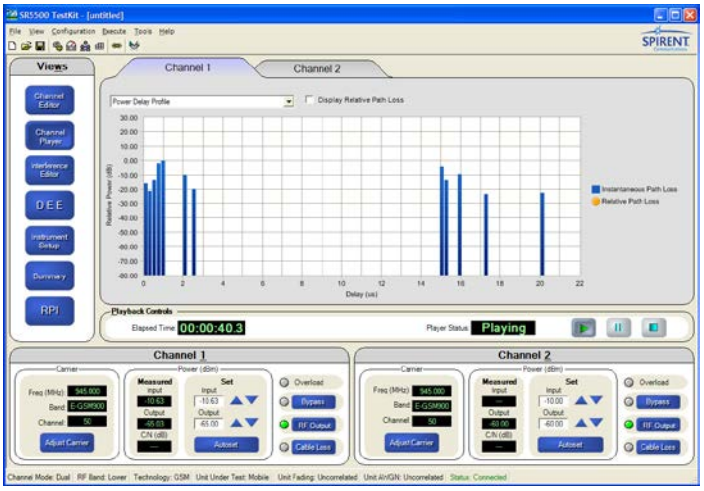


Figure 2-22: Channel Player Window

If the fading emulation playback is paused or stopped, the Channel Player view remains static. If the playback is running, the Channel Player view constantly changes to show the latest update in the fading emulation playback. The Channel Player features two unique presentations. Change the presentation using the list box located above the graph.

The first presentation, the *Power Delay Profile* shows the instantaneous Power Delay Profile. The delay for each path is represented by the position of each bar on the X axis (Delay). The power of each path is represented by the height of each bar along on the Y axis (Power). The *Display Relative Path Loss* checkbox shows and hides the average power indicator for each path.

If Additive Impairments are enabled on the selected channel a horizontal line representing the relative power of the impairment to the channel displays in the Player view.

NOTE: The average power indicated for each path is relative to the total composite output power of the channel. This does not map directly to the path loss settings in the Channel Editor table.

A second presentation, the *Power Delay Profile History* is similar to the first presentation, but also displays a brief history. The older instantaneous Power Delay Profiles move back along the Z axis (time) and the current DPD is added to the front.

Figure 2-23: Power Delay – Profile History

Figure 2-22 displays the Player View in 2x2 MIMO mode. This presentation is similar to the first, but all four MIMO sub-channels are shown simultaneously.

Figure 2-24: Power Delay –2x2 MIMO Mode

Figure 2-25 displays the Player View in 4x4 MIMO mode. This presentation is similar to the first, but all sixteen MIMO sub-channels are shown simultaneously.

SR5500 TestKit - [untitled]
File View Configuration Execute Tools Help
Selected Unit: 1-2 Synchronized
SPIRENT
Views
Channel Editor
Channel Player
Interference Editor
DEE
Instrument Setup
Summary
RPI
Unit 1-2 MIMO Channel
Power Delay Profile - 4x4 MIMO
Relative Power (dB)
Delay (us)
Playback Controls (All Units)
Elapsed Time 00:01:31.2
Player Status Playing
Carrier
Freq (MHz): 870.030
Band: BC0
Channel: 286
Adjust Carrier
Port
Unit 1-2 (Input)
Measured Input (dBm)
Set Input (dBm)
Unit 1-2 (Output)
C/N Ratio
Measured Output (dBm)
Set Output (dBm)
RF1 -9.90 -10.00 Autoset Overload --- -60.00 -60.00 RF Output Bypass Cable Loss
RF2 -10.01 -10.00 Autoset Overload --- -60.05 -60.00 RF Output Bypass Cable Loss
RF3 -9.74 -10.00 Autoset Overload --- -59.81 -60.00 RF Output Bypass Cable Loss
RF4 -9.79 -10.00 Autoset Overload --- -59.86 -60.00 RF Output Bypass Cable Loss
Channel Mode: 4x4 MIMO | RF Band: Lower | Technology: CDMA2000 | Unit Under Test: Mobile | Unit Fading: Uncorrelated | Status: Connected

Figure 2-25: Power Delay – 4x4 MIMO Mode

2.6. File Operations

SR5500 TestKit supports saving and recalling files to simplify configuration of the SR5500. As with most Windows applications, certain settings are saved in the file. When the file is opened at a later time, those settings are restored.

Select **File› New Settings File** to reset settings back to their default values. **Use Open Settings File**, **Save Settings File**, **Save Settings File As**, just as you would with any other Windows application. Use the appropriate toolbar icons instead of selecting from the **File** menu.

2.6.1. Settings Saved in the Settings File

The following settings are saved in the *Settings File* and restored after opening a settings file:

- System configuration (Channel Configuration and RF Frequency Mode).
- Test Assistant settings (Technology, Unit Under Test, Band, Channel, Profile).
- Channel I/O settings (Carrier Frequency, Input Power, Output Power, Bypass).
- All path settings in the Channel Editor view.

NOTE ON MULTI-UNIT USE: The settings for all four units are always saved in the settings file. This is true even if only one unit is currently active. In previous versions of TestKit, the number of active units was stored in the system registry. For versions 3.0 and higher, the number of systems is stored in and recalled from the settings file.

The following settings are saved in the *System Registry* and restored after opening TestKit:

- Communications settings for connected units. (IP address, etc.).

2.6.2. Load PDP From File

When loading PDP settings from a WCE file, only settings from the Channel Editor table are loaded. In GCM mode, the XPD value is also loaded; the antenna polarization and signal direction settings are not.

2.6.3. STX Files

STX files are available if the instrument has the VDT-CT option available. STX files are the result of the Virtual Drive Test Conversion Tool and contain system configuration, Channel I/O, path information, and DEE information. To configure TestKit SR5500 to execute the VDT scenario, select **Virtual Drive Test (*.stx)** from the list in the *Open File* window and select an **STX file**.

2.6.4. Recent File List

SR5500 TestKit maintains a list of the four most recently used files. These files display at the end of the **File** menu. To recall a file that on the list, select it from the **File** menu.

2.7. Operational Detail

This section details the parameters that control the Channel Input and Output and the Path Fading parameters.

2.7.1. Channel I/O Parameters

Properly setting the Channel Input and Output parameters ensure the target signal is not compromised in terms of fidelity and power, and produces the highest level of performance from the SR5500. This section details the Channel I/O Parameters.

2.7.1.1 Selecting Instrument Configuration

The SR5500 can be configured for a Single Channel Mode, Dual Channel Mode, RX Diversity Mode, TX Diversity Mode, 2x2 MIMO Mode or, 4x4 MIMO Mode. MIMO Modes (2x2 and 4x4) require the purchase of both a hardware and software option. Refer to Section 2.3 on page 32 for a description of the different channel modes. Set the number of Channels and Paths in the *System/Communication Setup* window. To access this window, select **Configuration›System/Communication Setup**, or click the **System/Communication Setup** icon from the toolbar.

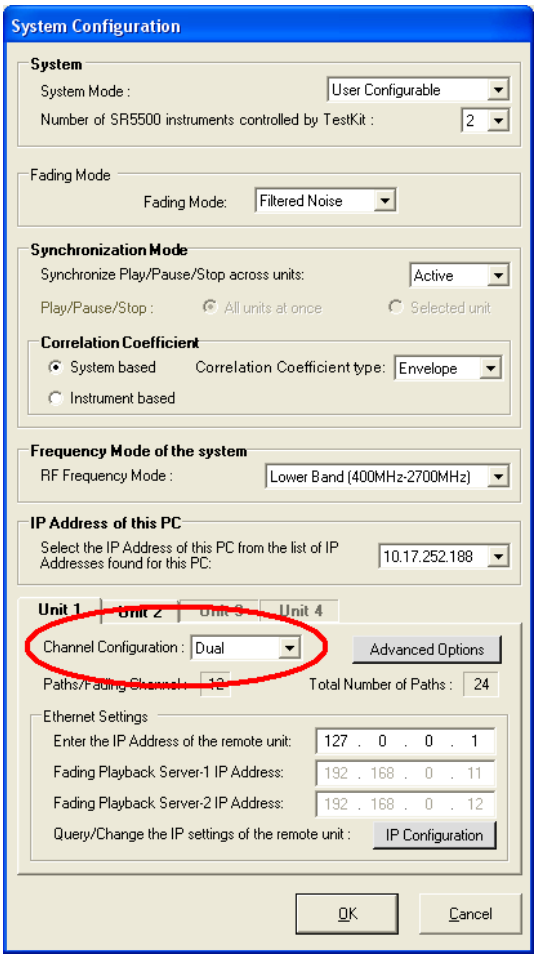


Figure 2-26: System Configuration Window

2.7.1.2 Bypass Mode during File Recall and DEE Disable

To maintain the connection between the devices connected to SR5500, you can force the SR5500 to bypass mode during file recall and DEE bypass using the Advanced Configuration Options Window, as shown in Figure 2-27.

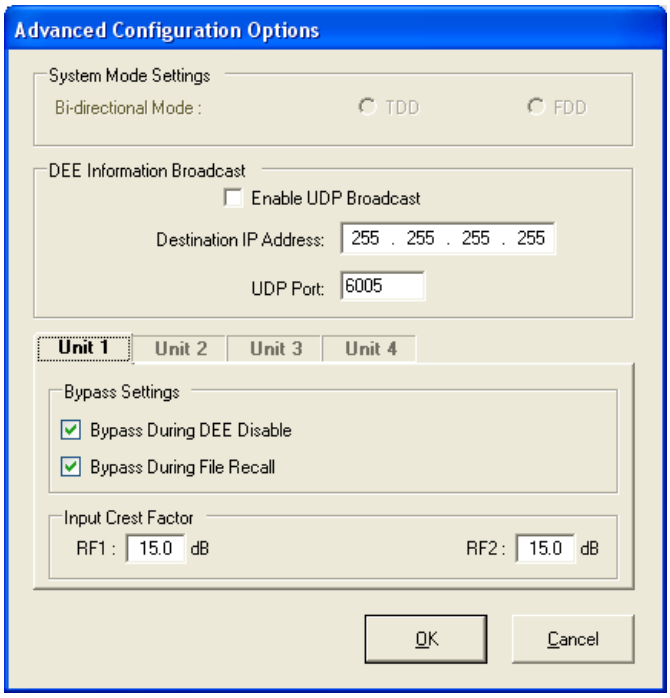


Figure 2-27: Advanced Configuration Options Window

2.7.1.3 Setting the Channel Crest Factor

The Channel Crest Factor is a measure of the maximum peak/avg power ratio that the SR5500 can accept without causing an overload condition. You can configure each channel of the SR5500 to have a larger than default crest factor setting by using the System Configuration window, shown in Figure 2-26. To access this window, select **Configuration›System/Communication Setup**, or click the **System/Communication Setup** icon from the toolbar.

The SR5500 Crest Factor is set to **15 dB**, which is sufficient for most applications. You can set larger values when required by the application.

NOTE: Increasing this value limits the maximum output power of the SR5500. Additionally, system noise and spurious performance will be degraded.

2.7.1.4 Adjusting the Carrier Frequency

The Carrier Frequency must be set appropriately for each channel in order for the SR5500 to function properly. The Carrier Frequency displays in the Channel controls and indicators, as shown in Figure 2-28 and Figure 2-29.

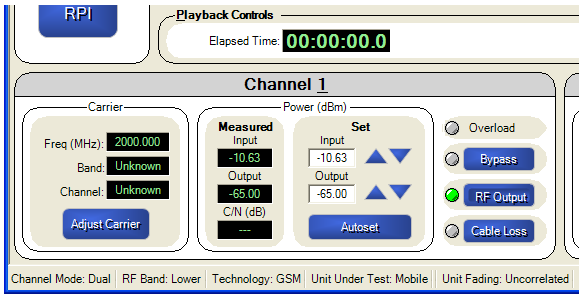


Figure 2-28: Channel Controls and Indicators – Dual Channel Mode

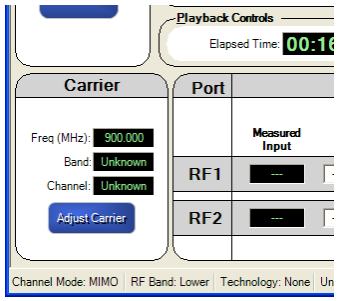


Figure 2-29: Channel Controls and Indicators –2x2 MIMO Mode

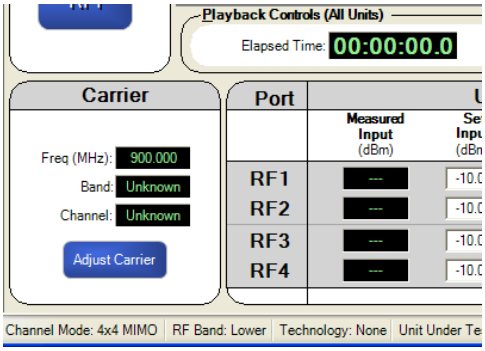


Figure 2-30: Channel Controls and Indicators –4x4 MIMO Mode

To change the Carrier Frequency, click the **Adjust Carrier** button. SR5500 TestKit displays the *Channel Adjust Carrier Frequency* window.

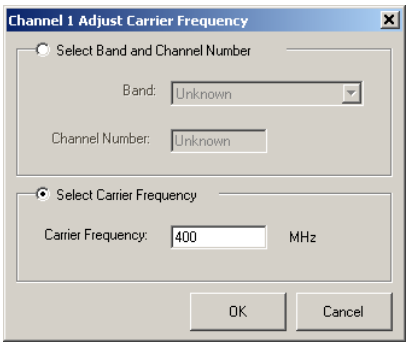


Figure 2-31: Channel Adjust Carrier Frequency Window

Adjust the carrier by setting the **Band** and **Channel**, or by selecting the **Carrier Frequency** directly in MHz.

To set the Band and Channel:

1. Click the Select Band and Channel Number button.
2. Select the appropriate **Band** from the list box.
3. Enter the appropriate channel in the **Channel Number** textbox.
   If the values you enter are valid, SR5500 TestKit displays the corresponding Carrier Frequency in MHz in the read-only Carrier Frequency textbox.

If you want to change the currently selected Technology and/or Unit Under Test, use the Test Assistant. For details on using the Test Assistant, refer to Section 2.3. on page 32.

To set the Carrier Frequency in MHz directly:

1. Click the Select Carrier Frequency button.
2. Edit the **Carrier Frequency** in MHz in the textbox.
3. Click **OK** to save the changes and close the window.
   To cancel the changes, click the **Cancel** button.

2.7.1.5 Input and Output Level Control Overview

Both the SR5500 input ranging circuit and nominal output level can be manually configured. Set the input ranging circuitry to match the RMS signal power present at the input port to the SR5500. The output level parameter determines the nominal RMS output power present at the output port of the SR5500.

NOTE: The output power level specified will only be accurate if the measured input power matches the set input power settings.

To achieve the ideal performance from the SR5500, you must properly configure the SR5500 input ranging circuit to the RMS input power. The SR5500 can measure the input signal and automatically set the input ranging circuit, or you can manually set the input ranging circuit. There are special concerns with directly setting these levels. Refer to Section 2.7.1.6. on page 47 for details on setting the Input Power manually. Access the automated level control functionality through the Autoset feature. Refer to page 45 for details on the Autoset feature. SR5500 measures and reports the input power level in SR5500 TestKit. Refer to the Section on Measured Input and Output Power Indicators on page 51 for details.

NOTE: If the SR5500 is equipped with the SR5500 6 GHz(-EX) RF Converter, all input and output power references are mapped to the input and output of the SR5500 6 GHz(-EX) RF Converter.

2.7.1.6 Using Autoset

The Autoset feature measures the input signal power and configures the channel signal levels for optimal output performance. The SR5500 performs the Autoset function once each time you click the **Autoset** button. The SR5500 does not continually re-range for changing input signal powers.

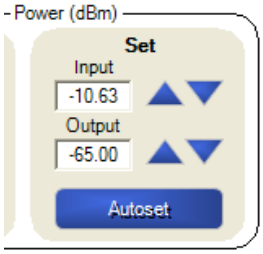


Figure 2-32: Autoset Option – Dual Channel Mode

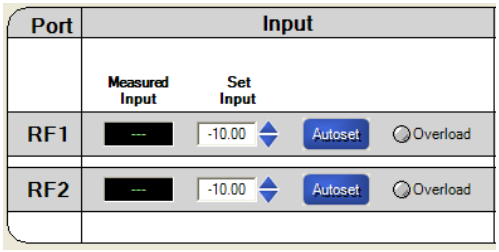


Figure 2-33: Autoset Option – 2x2 MIMO Mode

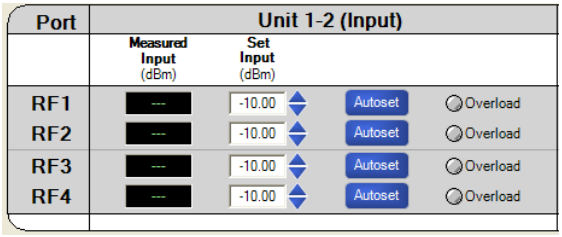


Figure 2-34: Autoset Option – 4x4 MIMO Mode

To perform an Autoset:

1. Apply the appropriate input signal to the SR5500, and click the **Autoset** button. The SR5500 measures the RMS input level and sets the correct input level circuitry.
2. The SR5500 also adjusts the output attenuation to achieve the set nominal RMS output level. If the Autoset is successful, TestKit automatically updates the Set Input level textbox.
3. If the Autoset is unsuccessful, TestKit reports the problem. If the input signal is bursty, set the Power Meter in **Triggered Mode** to measure the input signal correctly. Refer to Section 3.10 on page 163 for more details on Triggered Mode.

NOTE: As the input signal level changes over time, the output level changes by an equal amount. It may be necessary to repeat the Autoset because the SR5500 does not automatically repeat the function. Make sure your measured input power equals set input power.

2.7.1.7 Manually Setting the Input Power

The Input Ranging Circuit can be configured manually. To perform this operation, enter the RMS power present at the SR5500 input in the *Set Input* textbox in TestKit.

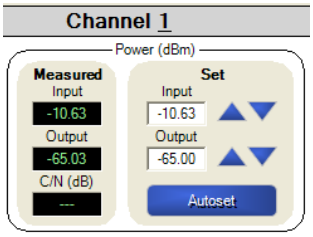


Figure 2-35: Input Power Controls– Dual Channel Mode

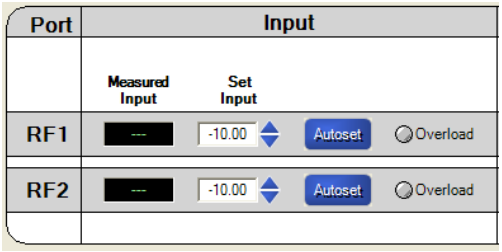


Figure 2-36: Input Power Controls – 2x2 MIMO Mode

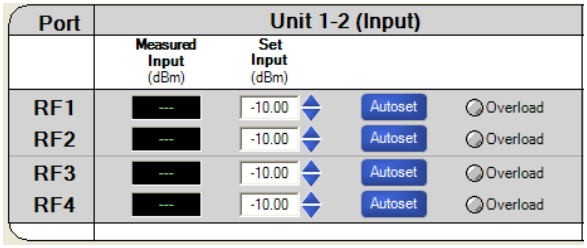


Figure 2-37: Input Power Controls – 4x4 MIMO Mode

You can also change the Input Level by clicking the **Up** and **Down** arrows to adjust the value in the textbox. The value of the Set Input increases or decreases by 1 dB increments. Holding down the **Up** or **Down** arrows causes the value in the textbox to change more rapidly.

Examples of input signals that may require manual input level control include:

- A carrier signal with a variable input level.
- A bursty signal with a short ON time.

If the carrier signal has a variable input level, configure the *Set Input* textbox to the maximum expected RMS input signal power.

2.7.1.8 Input Overload Condition

If the SR5500 detects that the input signal level is higher than expected by the input circuitry, an overload condition exists. During an Overload condition, the Overload LED on the front panel of the SR5500 displays. TestKit also illuminates the Overload indicator in the Channel Control and Indicators area, and on the status bar.

Figure 2-38: Overload Indicator – Dual Channel Mode

Figure 2-39: Overload Indicator – MIMO Mode (2x2 and 4x4)

Figure 2-40: Overload Indicator – Status Bar

During an Overload condition, the input signal is too high to be properly sampled by the unit input circuitry. Therefore, the SR5500 may cause undesired distortion of the input signal. If the Overload condition exists, or periodically reoccurs, one or more of the following actions may be necessary:

4. Reduce the signal level input to the SR5500.
5. Repeat the Autoset or manually set the input level with a signal level more representative of its nominal level.

2.7.1.9 Global Overload Indicator

When controlling multiple SR5500 units (refer to Section 2.14.4), and an Overload condition occurs on any instrument in the system, an indication of the Overload condition is provided on the Unit Selection Tool, as shown in Figure 2-41.

Figure 2-41: Unit Selection Tool– Global Overload Indicator

In Figure 2-41, Unit 2 has an Overload condition. For more information on unit selection, refer to 2.14.5.

2.7.1.10 Adjust the Power Meter Parameters.

The SR5500 contains a Power Meter that measures the signal levels coming into the unit. The default Power Meter parameter settings are appropriate for most applications.

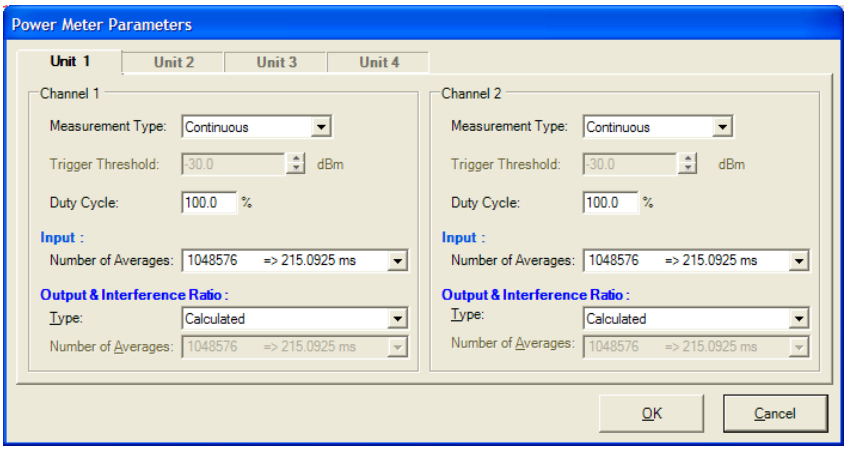


Figure 2-42: Power Meter Parameters Window

You can configure the Power Meter in **Continuous** or **Triggered** mode. If you know the duty cycle of the signal, enter the value and the Power Meter makes the appropriate offset for both the input and output measurements. Refer to Section 3.10 on page 163 for more details on the Triggered Mode.

For example, if the input signal is a half rate signal (on only half the time), you can set the duty cycle parameter to 50%. This setting only impacts the measurement in Continuous mode.

In Continuous mode, the Power Meter constantly triggers and measures the signal.

In Triggered Mode, the Power Meter measures the signal when the input power is detected over the Trigger Threshold. When the Power Meter is set to Continuous, you have the choice of setting the output Power Meter type to Calculated or Measured. In the Triggered mode, only the Calculated mode is available.

When the output power measurement type is set to Calculated, the output power is determined based on the measured input level. The channel is assumed to have a constant fixed loss. This is true in most cases. If a model is setup with paths that are 180 degrees out of phase, this assumption may be incorrect.

When the output measurement type is set to Measured, the output is measured after fading.

The *Power Meter Configuration* window allows you to select the number of averages that determine a power measurement. In Continuous mode, the Power Meter measures over the configured time period and reports the average measurement. In Triggered mode, the Power Meter records instantaneous RMS power measurements when the Trigger threshold is satisfied.

The data is recorded and averaged when the total averaging time is reached. Refer to the Technical Reference chapter on page 142 for details on the relationship between Trigger Level, Averaging Time and the function of the triggered Power Meter.

2.7.1.11 Setting the Output Power

To set the nominal RMS output power level, enter the desired level in the *Set Output* textbox in SR5500 TestKit. If the Set Input level accurately shows the actual input signal level, the nominal RMS output level reflects the value in the *Set Output* textbox.

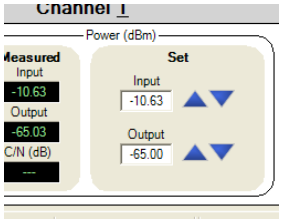


Figure 2-43: Output Power Controls– Dual Channel Mode

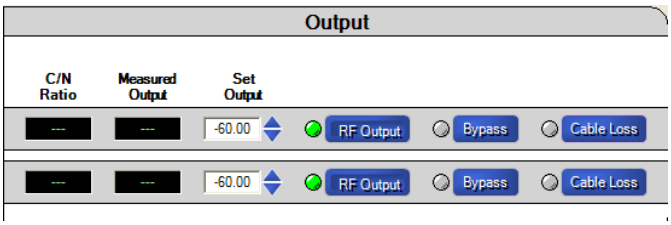


Figure 2-44: Output Power Controls –2x2 MIMO Mode

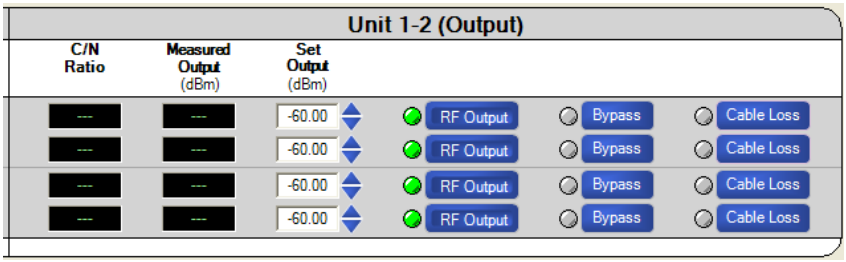


Figure 2-45: Output Power Controls – 4x4 MIMO Mode

You can also change the nominal RMS output power level by clicking the **Up** and **Down** arrows to adjust the value in the textbox. The value of the the Nominal RMS Output Power increases or decreases by 1.0 dB increments. Holding down the **Up** or **Down** arrows causes the value in the textbox to change more rapidly.

NOTE: The following are some of the conditions that can cause the Nominal RMS Output Power to vary from the entered value:

- Input power measured does not match the Set Input textbox.
- Playback Engine in Pause mode.
- Channel Bypass active.
- Closed Loop Power Control causes the mobile power to be correlated with the fading channel.
- Sub-channels are disabled in the *MIMO Advanced Options* windows.
- No paths enabled for this channel.
- Output Cable Loss correction factor is incorrectly set.

2.7.1.12 Measured Input and Output Power Indicators

The SR5500 has built-in Power Meters that enable real-time monitoring of the input and output. TestKit displays these power measurements in the *Power Measurement Input* and *Output* textboxes. The input power measurement enables you to quickly determine the accuracy of the Set Input value. The output power measurement represents the average output power of the SR5500. If an interferer is enabled, TestKit displays the measured C/N ratio. This measurement is based on the current measured output power and the set C/N ratio.

You can set the output power measurement to one of two modes; Calculated or Measured. In Calculated mode, the output power displays based on the measured input level and the known loss of the channel. In this mode, the output measurement does not respond to instantaneous changes in output power level caused by fast or slow fading. This mode is useful when the Doppler is very low.

When set to Measured mode, the output power is measured and displayed after fading is performed. The output power in this mode varies instantaneously with fading. The Measured mode is not available when the Power Meter is set to Triggered mode.

2.7.1.13 Adjusting the Output Power Cable Loss Correction Factors

The SR5500 has the ability to set an offset to compensate for cable loss for both the Set and Measured Power indicators. To perform this operation, click the **Cable Loss** button in SR5500 TestKit.

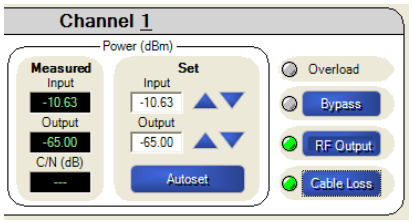


Figure 2-46: Cable Loss Button – Dual Channel Mode

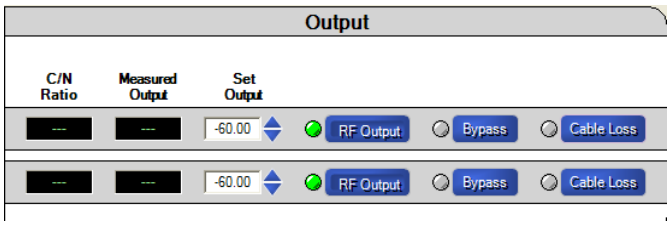


Figure 2-47: Cable Loss Button – 2x2 MIMO Mode

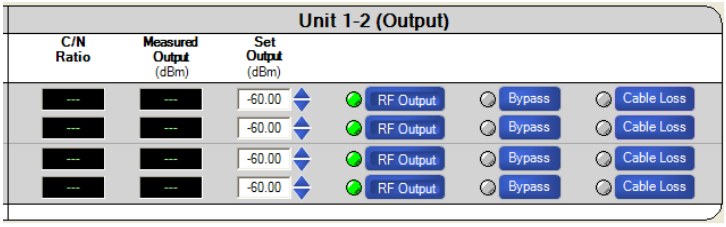


Figure 2-48: Cable Loss Button – 4x4 MIMO Mode

This opens the *Cable Loss Setting* window. This window allows you to enter a value for the loss associated with a cable connected to the output port of the SR5500. When enabled, a green LED lights up next to the **Cable Loss** button on the interface. When enabled, any output level in the output level textbox is offset by the cable loss value. For example, if a cable connecting the device has 1.2 db of loss associated with it, enter this value in the *Cable Loss Setting* window. If you then set the output level of the SR5500 to –50 dBm, the actual level at the RF output port of the SR5500 would be set to –48.8 dBm, but the level at the Unit Under Test would be –50dbm.

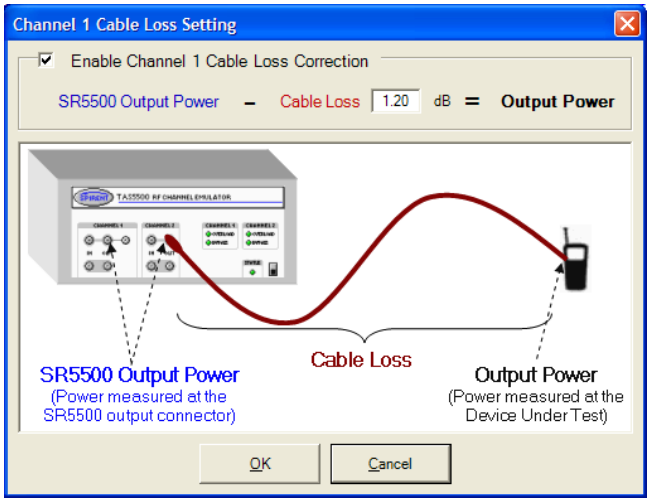

Channel 1 Cable Loss Setting
Enable Channel 1 Cable Loss Correction
SR5500 Output Power – Cable Loss 1.20 dB = Output Power
Cable Loss
SR5500 Output Power
(Power measured at the SR5500 output connector)
Output Power
(Power measured at the Device Under Test)
OK
Cancel

Figure 2-49: Cable Loss Setting Window

2.7.1.14 Adjusting the RF Port Phase Correction Factors

The SR5500 has the ability to apply a phase offset to each of the RF ports. If the unit is powered down, or the ambient temperature changes, the nominal phase through the unit changes as well. Allow the unit to warm up before taking any phase measurements or setting any offsets. We recommend you verify the phase correction factors before beginning a round of testing. To access this window, select **Configuration›Phase Calibration**, or click the **Phase Calibration** icon Φ from the toolbar.

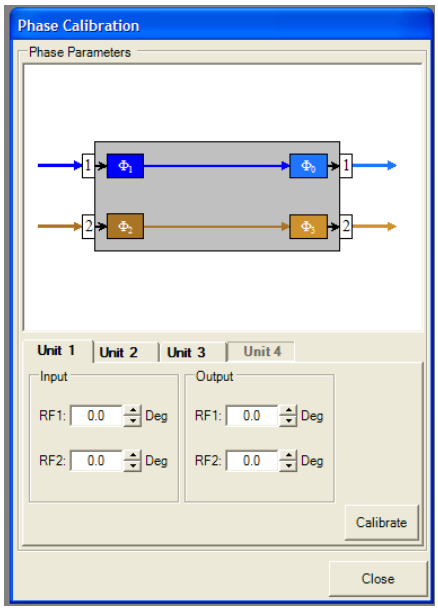


Figure 2-50: Phase Calibration Window - Dual Channel Mode

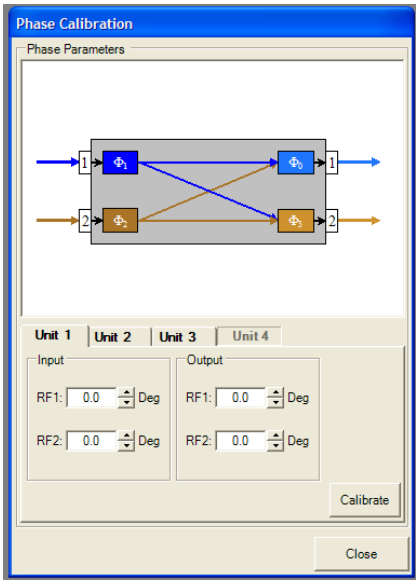


Figure 2-51: Phase Calibration Window - 2x2 MIMO Mode

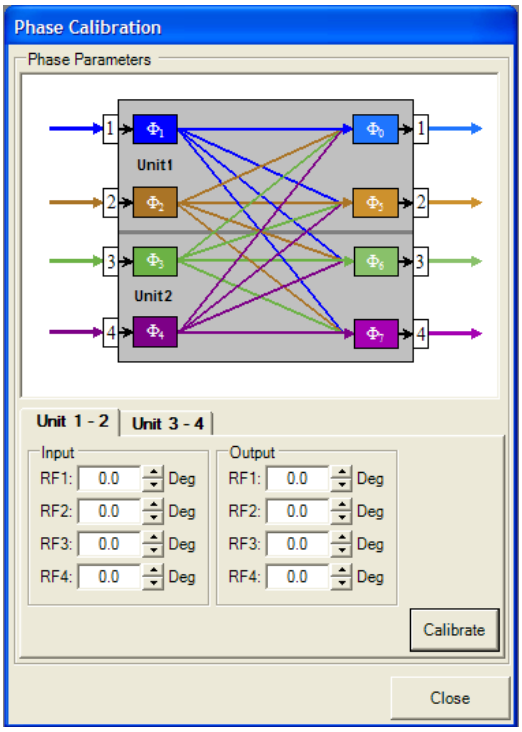


Figure 2-52: Phase Calibration Window - 4x4 MIMO Mode

In MIMO Mode (2x2 and 4x4), a Calibration Wizard is available to assist in equalizing the phase of the different sub-channels. The calibration Wizard allows you to perform the phase calibration using the internal circuitry of the SR5500 (Automatic Mode), or perform the measurements manually with a Network Analyzer or similar equipment (Manual Mode). The Automatic Mode eliminates the need for a Network Analyzer.

Before running the wizard, set the input and output levels as they would be during testing. The Calibration Wizard takes you through measurement steps for 2x2 MIMO (4x4 MIMO) mode. You need to be connected to the units in MIMO mode (2x2 or 4x4) to perform calibration with the Phase Calibration Wizard. The Phase Calibration Wizard defaults to Manual Mode.

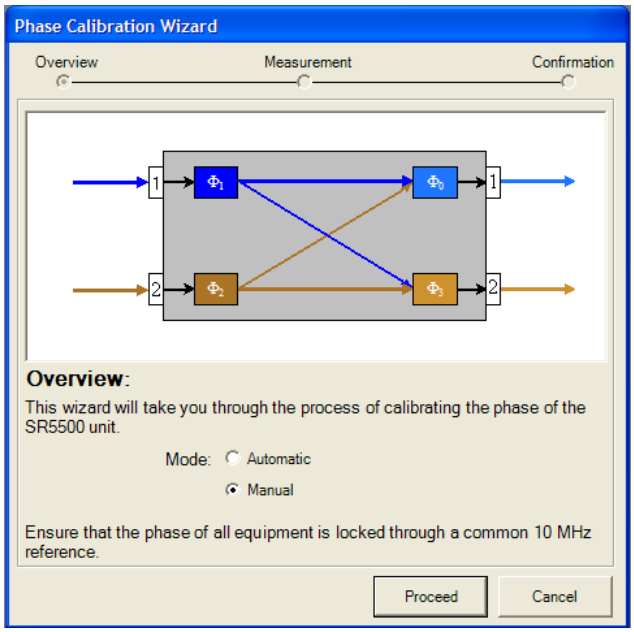


Figure 2-53: Phase Calibration Wizard – Overview

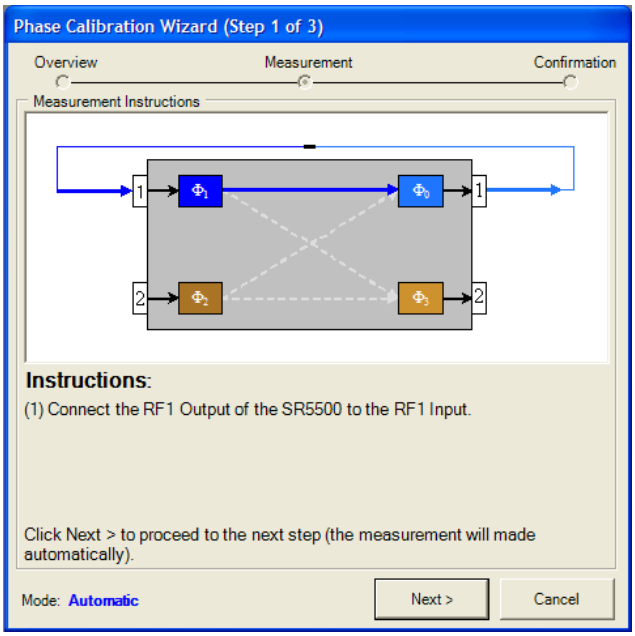

Phase Calibration Wizard (Step 1 of 3)
Overview
Measurement
Confirmation
Measurement Instructions
Instructions:
(1) Connect the RF1 Output of the SR5500 to the RF1 Input.
Click Next > to proceed to the next step (the measurement will made automatically).
Mode: Automatic
Next >
Cancel

Figure 2-54: Phase Calibration Wizard – Step One-Automatic Mode

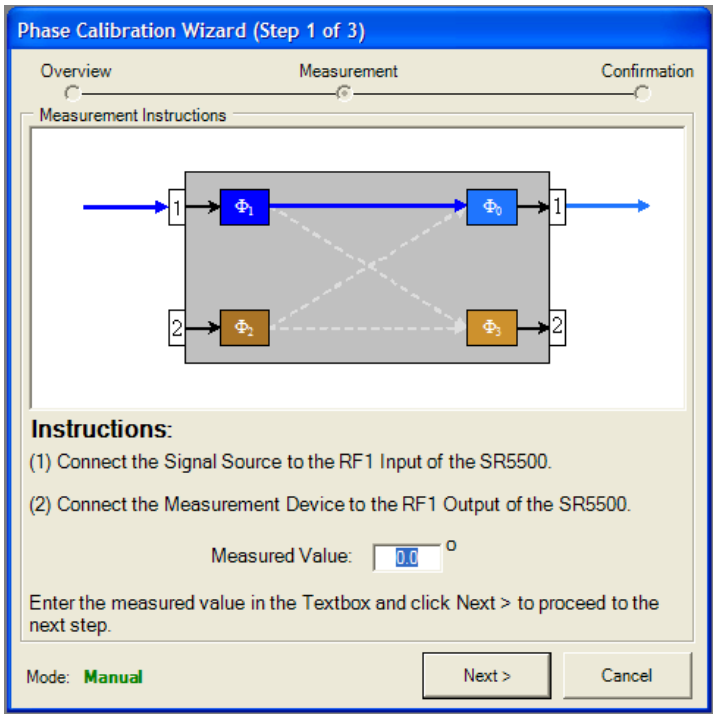

Phase Calibration Wizard (Step 1 of 3)
Overview
Measurement
Confirmation
Measurement Instructions
Instructions:
(1) Connect the Signal Source to the RF1 Input of the SR5500.
(2) Connect the Measurement Device to the RF1 Output of the SR5500.
Measured Value:
0.0
Enter the measured value in the Textbox and click Next > to proceed to the next step.
Mode: Manual
Next >
Cancel

Figure 2-55: Phase Calibration Wizard – Step One-Manual Mode

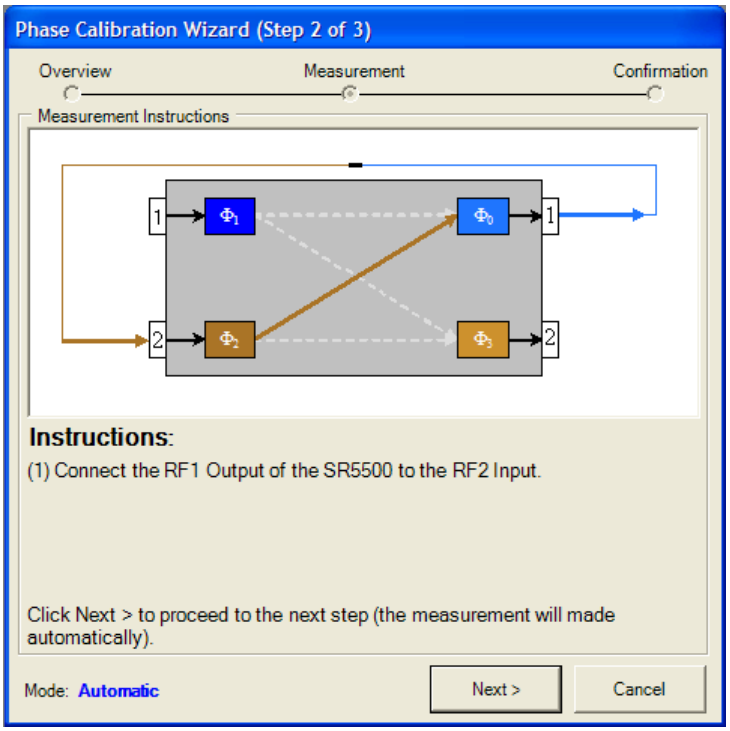

Phase Calibration Wizard (Step 2 of 3)
Overview
Measurement
Confirmation
Measurement Instructions
Instructions:
(1) Connect the RF1 Output of the SR5500 to the RF2 Input.
Click Next > to proceed to the next step (the measurement will made automatically).
Mode: Automatic
Next >
Cancel

Figure 2-56: Phase Calibration Wizard – Step Two-Automatic Mode

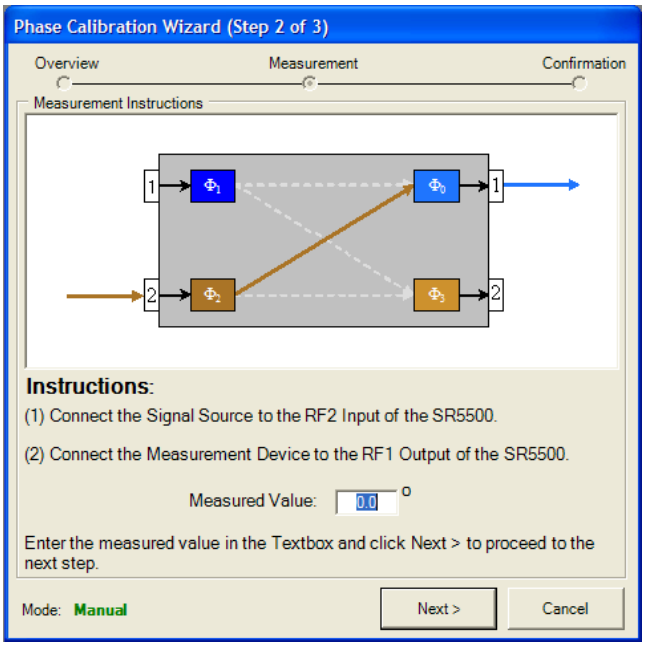

Phase Calibration Wizard (Step 2 of 3)
Overview
Measurement
Confirmation
Measurement Instructions
Instructions:
(1) Connect the Signal Source to the RF2 Input of the SR5500.
(2) Connect the Measurement Device to the RF1 Output of the SR5500.
Measured Value:
0.0
Enter the measured value in the Textbox and click Next > to proceed to the next step.
Mode: Manual
Next >
Cancel

Figure 2-57: Phase Calibration Wizard – Step Two-Manual Mode

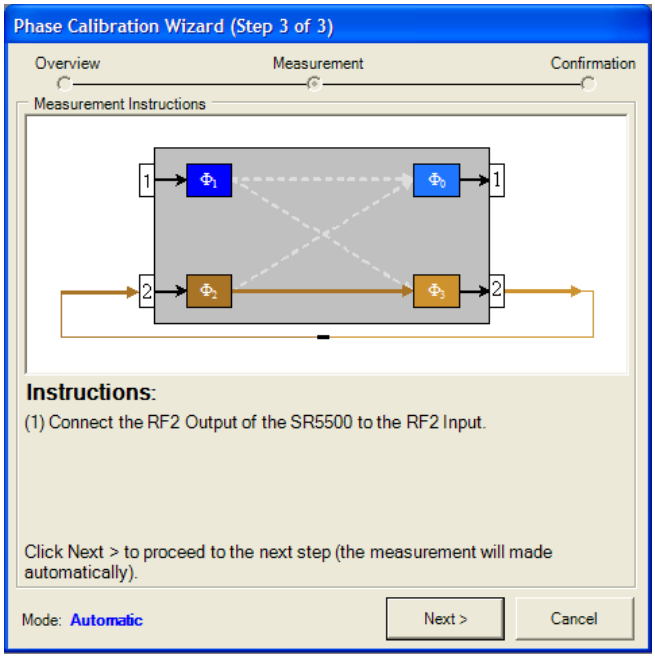

Phase Calibration Wizard (Step 3 of 3)
Overview
Measurement
Confirmation
Measurement Instructions
Instructions:
(1) Connect the RF2 Output of the SR5500 to the RF2 Input.
Click Next > to proceed to the next step (the measurement will made automatically).
Mode: Automatic
Next >
Cancel

Figure 2-58: Phase Calibration Wizard – Step Three-Automatic Mode

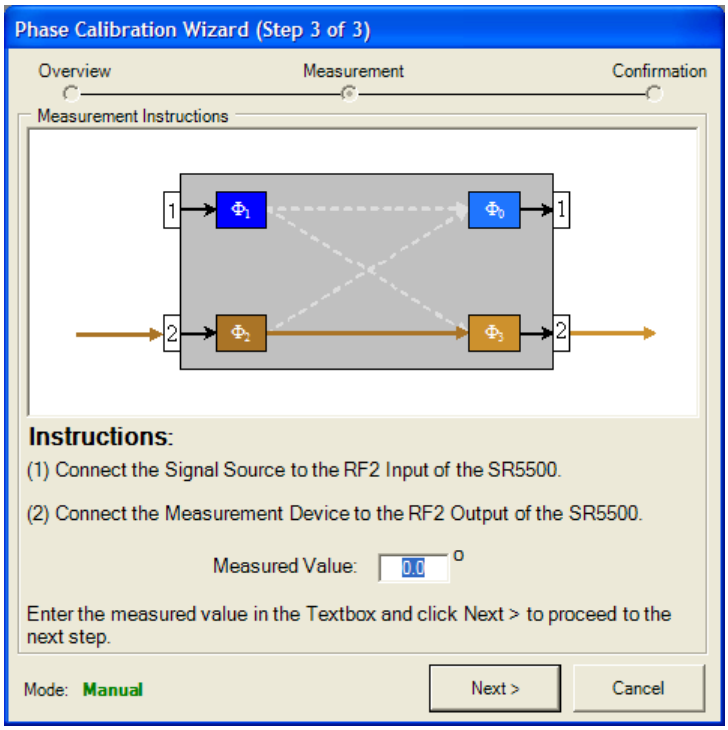

Phase Calibration Wizard (Step 3 of 3)
Overview
Measurement
Confirmation
Measurement Instructions
Instructions:
(1) Connect the Signal Source to the RF2 Input of the SR5500.
(2) Connect the Measurement Device to the RF2 Output of the SR5500.
Measured Value:
0.0
Enter the measured value in the Textbox and click Next > to proceed to the next step.
Mode: Manual
Next >
Cancel

Figure 2-59: Phase Calibration Wizard – Step Three-Manual Mode

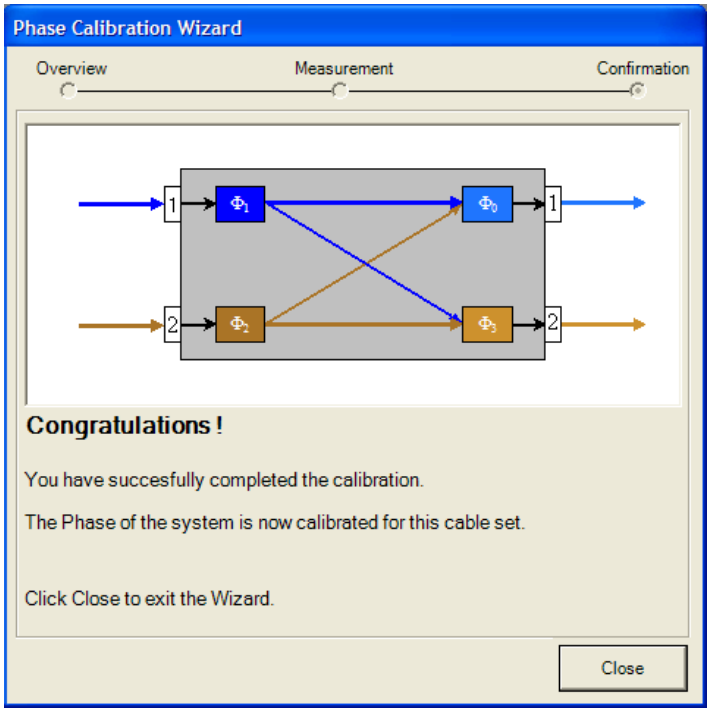


Figure 2-60: Phase Calibration Wizard – Confirmation - 2x2 MIMO Mode

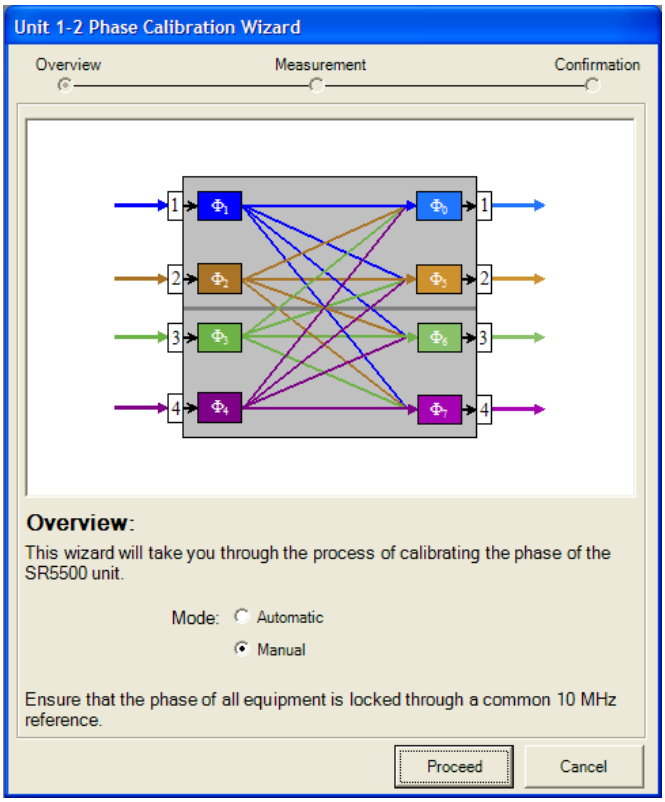


Figure 2-61: Unit 1-2 Phase Calibration Wizard – Selecting 4x4 MIMO Mode

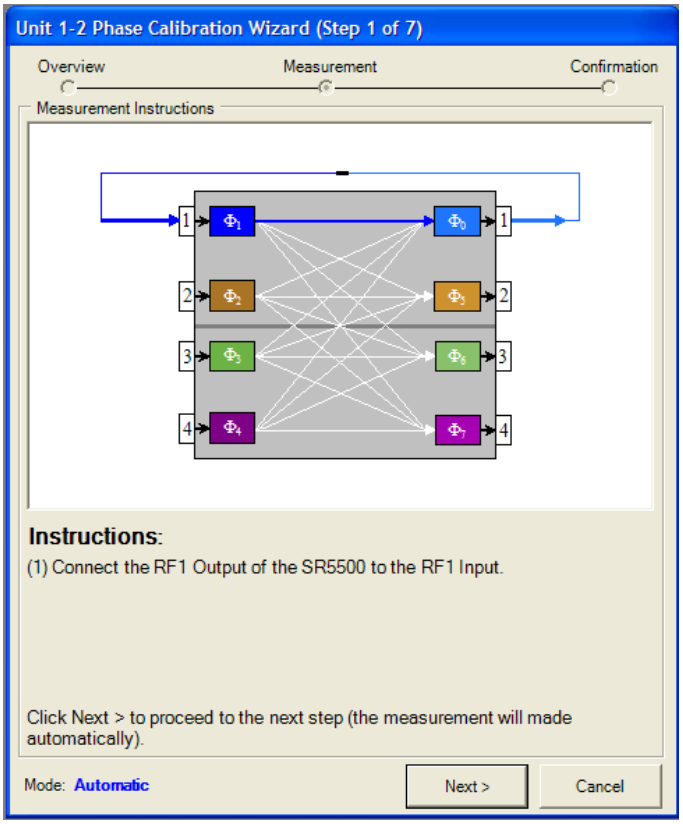

Unit 1-2 Phase Calibration Wizard (Step 1 of 7)
Overview
Measurement
Confirmation
Measurement Instructions
Instructions:
(1) Connect the RF1 Output of the SR5500 to the RF1 Input.
Click Next > to proceed to the next step (the measurement will made automatically).
Mode: Automatic
Next >
Cancel

Figure 2-62: Unit 1-2 Phase Calibration Wizard – Automatic Mode

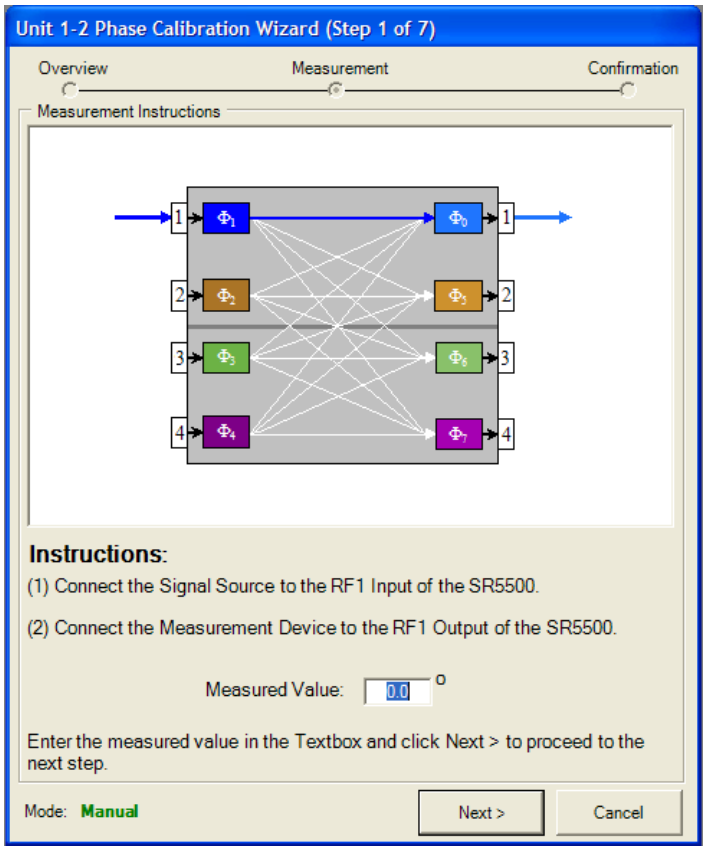

Unit 1-2 Phase Calibration Wizard (Step 1 of 7)
Overview
Measurement
Confirmation
Measurement Instructions
Instructions:
(1) Connect the Signal Source to the RF1 Input of the SR5500.
(2) Connect the Measurement Device to the RF1 Output of the SR5500.
Measured Value:
0.0
o
Enter the measured value in the Textbox and click Next > to proceed to the next step.
Mode: Manual
Next >
Cancel

Figure 2-63: Unit 1-2 Phase Calibration Wizard – Manual Mode

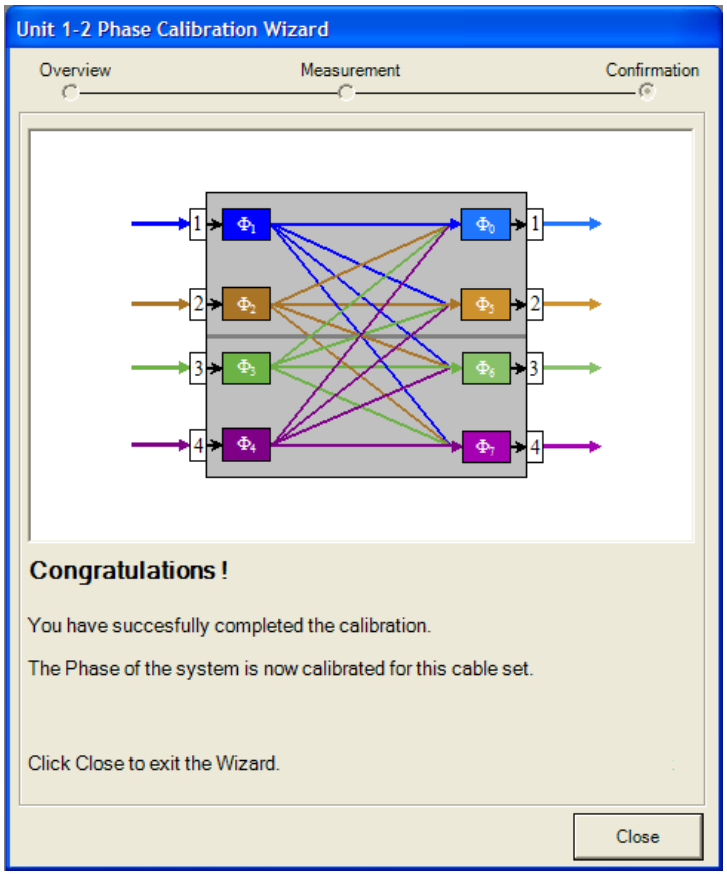
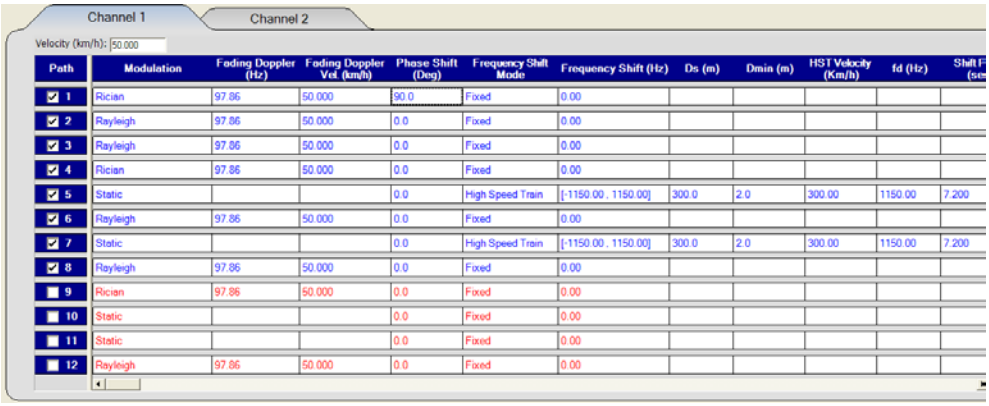


Figure 2-64: Unit 1-2 Phase Calibration Wizard – Confirmation - 4x4 MIMO Mode

2.7.2. Path Parameters

To use the Channel Editor view to edit the Path Parameters, click the **Channel Editor** button on the left to show the Path Parameters. SR5500 TestKit displays the Channel Editor in the View Area as shown in Figure 2-65.



Path	Modulation	Fading Doppler (Hz)	Fading Doppler Vel. (km/h)	Phase Shift (Deg)	Frequency Shift Mode	Frequency Shift (Hz)	Ds (m)	Dmin (m)	HST Velocity (Km/h)	fd (Hz)	Shift F (sec
1	Rician	97.86	50.000	90.0	Fixed	0.00					
2	Rayleigh	97.86	50.000	0.0	Fixed	0.00					
3	Rayleigh	97.86	50.000	0.0	Fixed	0.00					
4	Rician	97.86	50.000	0.0	Fixed	0.00					
5	Static			0.0	High Speed Train	[-1150.00 , 1150.00]	300.0	2.0	300.00	1150.00	7.200
6	Rayleigh	97.86	50.000	0.0	Fixed	0.00					
7	Static			0.0	High Speed Train	[-1150.00 , 1150.00]	300.0	2.0	300.00	1150.00	7.200
8	Rayleigh	97.86	50.000	0.0	Fixed	0.00					
9	Rician	97.86	50.000	0.0	Fixed	0.00					
10	Static			0.0	Fixed	0.00					
11	Static			0.0	Fixed	0.00					
12	Rayleigh	97.86	50.000	0.0	Fixed	0.00					

Figure 2-65: Path Parameters Window

The *Technical Reference* chapter on page 142 contains details on constructing a fading profile.

NOTE: In MIMO mode (2x2 and 4x4), when a change is made to a path parameter, this change is applied to the path in all sub-channels.

2.7.2.1 Using the Grid

The grid displays the current path parameter settings and allows you to change the current parameter settings. Each cell displays a unique parameter setting. Some parameter settings have a list of valid values, while others allow a range of values.

To change a value in the grid:

1. Select the appropriate cell.
   If the parameter has a list of values, a list box displays.
2. Click the list box to display the available choices. Click the desired value from the list to complete the change.
3. If the parameter has a range of values, a textbox displays. Adjust the value in the textbox to match the desired value. Press **Enter** when finished to complete the change.
4. To set the same value in all enabled paths, select the column by clicking the column name. Enter the desired value in any cell in the selected column.
   SR5500 TestKit updates all the enabled paths to match the new setting.

2.7.2.2 Accessing Path Modulation Parameters

The SR5500 supports numerous path parameters to accommodate a wide variety of testing demands. The grid can display all of these parameters. However, SR5500 TestKit is initially configured to display only the most commonly used parameters.

You can access the additional parameters two ways, by opening the *Path Modulation Parameters* window, or by adding the parameters to the grid.

To display the *Path Modulation Parameters* window, place the mouse cursor anywhere in the appropriate row in the **Path** Modulation column and click the **More** button that displays in the row.

Refer to 2.7.2.3 on page 64 for more details.

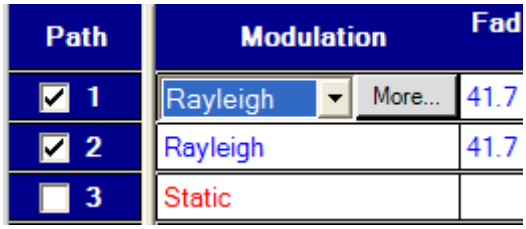


Figure 2-66: Modulation List

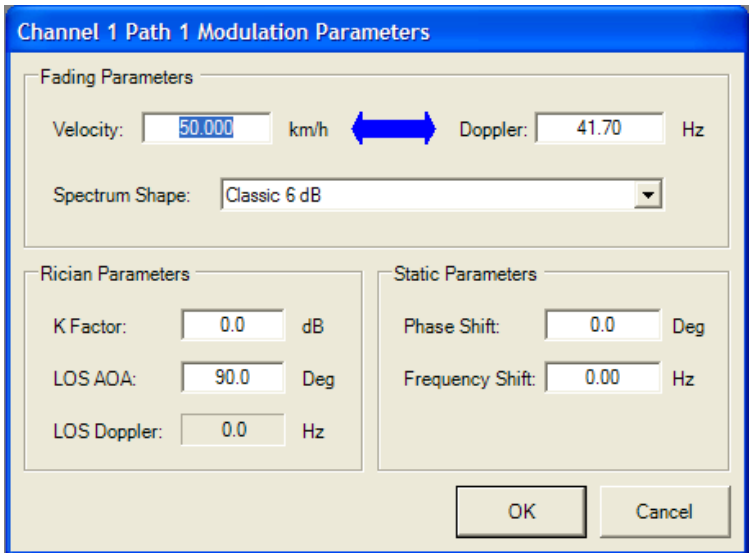


Figure 2-67: Path Modulation Parameters Window

The Phase Shift and Frequency Shift can be modified even the modulation is Static. However, the Frequency Shift cannot be modified if the Frequency Shift mode is High Speed Train. The Fading and Rician parameters can be modified only when the Modulation is set to Rayleigh/Rician and Rician respectively.

To add all of the path parameter columns to the grid, select **Menu›Configure›Table Format**, or click the **Table Format** icon in the toolbar. The *Table Configuration* window displays, as shown in Figure 2-68.

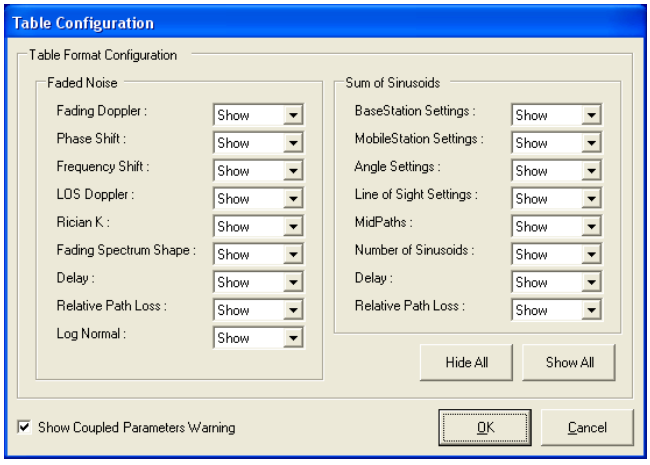


Figure 2-68: Table Format Configuration Window

This window allows you to select which columns display in the grid. Click the **Show All** button to display all of the columns. Click the **Default View** button to show only the most commonly used path parameters, including Path Status, Delay Mode, Delay Value, and Relative Path Loss columns.

Select the columns to display in the grid. Click **OK** to save the changes and close the window. Click **Cancel** to abandon the changes and close the window. The grid displays the updated settings.

2.7.2.3 Modulation

Use Path Modulation to set the Fading Type, such as Rayleigh or Rician. To change the Path Modulation, use the Path Modulation column in the grid shown in Figure 2-68.

NOTE: Setting all paths to "Off" disables the output signal.

2.7.2.4 Velocity and Doppler

To set a unique velocity for each path, use the Fading Doppler Vel column in the grid, or the Velocity textbox in the *Path Modulation Parameters* window.

To set a unique Doppler for each path, use the Fading Doppler column in the grid, or the Doppler textbox in the *Path Modulation Parameters* window.

The path Doppler setting is related to the Path Velocity setting. If you set the path Velocity, SR5500 TestKit calculates the path Doppler value and resets it appropriately. If you set the path Doppler, SR5500 TestKit calculates the path Velocity and resets it appropriately.

The Carrier Frequency, Doppler, and Velocity parameters are interdependent. When the Carrier Frequency is changed, SR5500 TestKit calculates the Doppler to maintain the currently set Velocity.

2.7.2.5 Spectrum Shape

The SR5500 allows you to select the Fading Spectrum Shape for each path with independently set status. You can only set the Fading Spectrum Shape for paths that are set to **Rayleigh** or **Rician**.

Use the column labeled **Fad. Spec. Shape** in the grid, or the Spectrum Shape list box in the *Path Modulation Parameters* window.

2.7.2.6 Rician Parameters

The following path parameters apply when the Path Status is set to **Rician**. To adjust the parameters in the grid or in the *Path Modulation Parameters window*, use the name shown in parenthesis below:

- Line of Site Angle of Arrival (LOS AOA)
- Line of Site Doppler (LOS Doppler)
- Rician K Factor (Rician K)

The LOS AOA and LOS Doppler are dependent. Setting one of these parameters causes the other to be reset to the appropriate calculated value. The Carrier Frequency, LOS AOA, and LOS Doppler parameters are interdependent. When the Carrier Frequency is changed, SR5500 TestKit calculates the LOS Doppler to maintain the currently set LOS AOA.

2.7.2.7 Modulator Parameters

Each path can have an independent Frequency Shift and Phase Shift value. To adjust the phase shift, use the Phase Shift column in the grid, or the Phase Shift textbox in the *Path Modulation Parameters window*.

2.7.2.8 Fixed Frequency Shift

To set a path for a Fixed Frequency Shift, set the Frequency Shift mode to Fixed by selecting it from the Frequency Shift Mode column. To set a value for the Fixed Frequency Shift in Hz independently for each path, use the Frequency Shift column as shown in Figure 2-25.

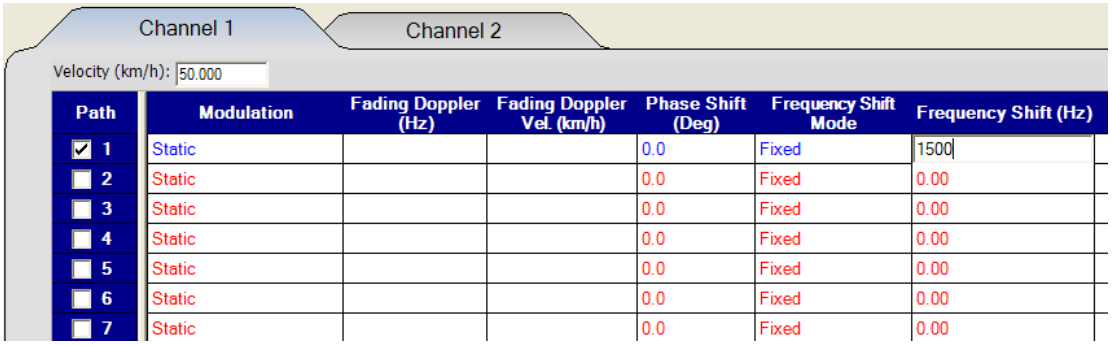


Figure 2-69: Frequency Shift in Fixed Mode

2.7.2.9 High Speed Train Frequency Shift

The SR5500 allows any number of paths to have High Speed Train Frequency Shift. Set the Frequency Shift Mode to High Speed Train, set the related parameters using the grid directly, as shown in Figure 2-70, or the *High Speed Train Parameters Frequency Shift* window, shown in Figure 2-72. To display the High Speed Train Frequency Shift Parameters window, click the Frequency Shift cell to display the **More** button, as shown in Figure 2-71. The *High Speed Train Frequency Shift Parameters* window plots the Frequency Shift and displays key characteristics such as, maximum and minimum values, and period of the Frequency Shift. Refer to Section 3.7.2 on page 154 for details on the High Speed Train Frequency Shift.

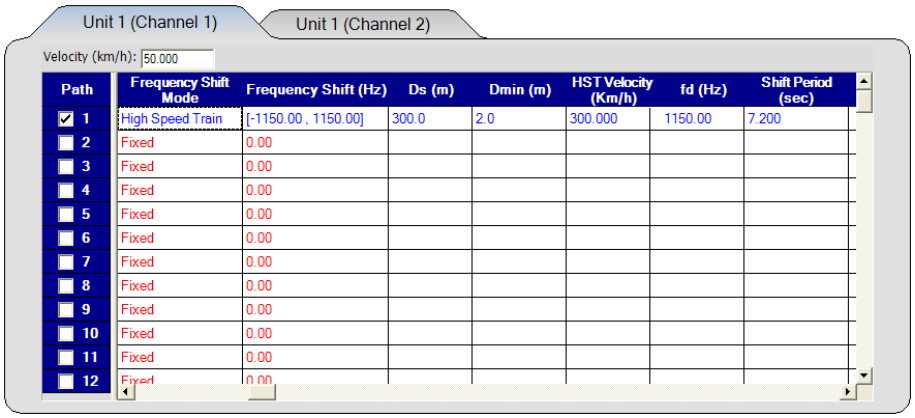


Figure 2-70: Frequency Shift in High Speed Train Mode

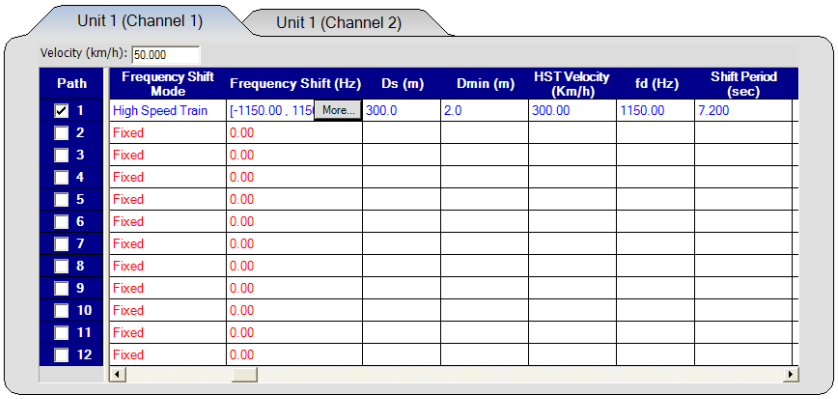


Figure 2-71: Frequency Shift – "More" Button

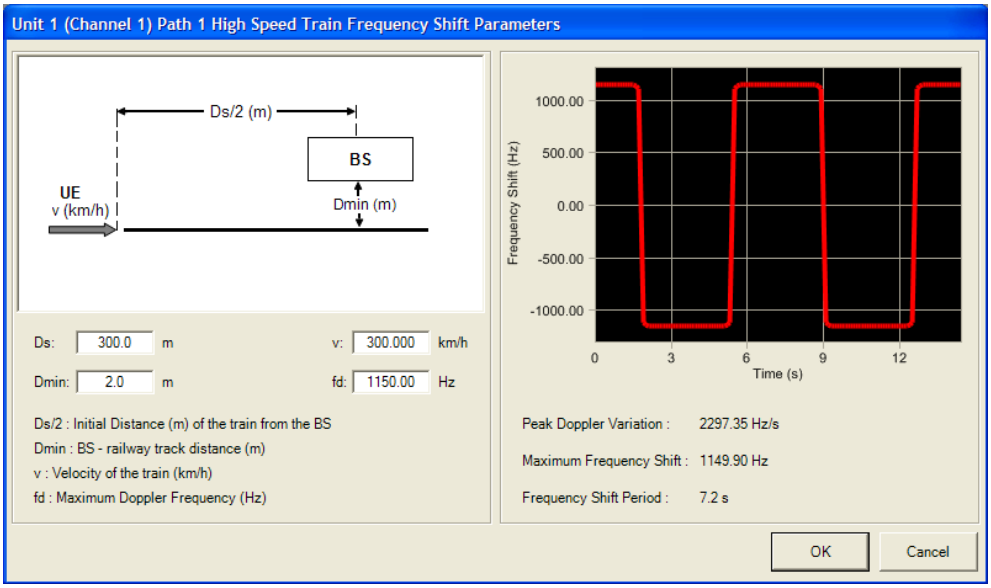


Figure 2-72: High Speed Train Frequency Shift Parameters Window

All the parameters presented in section to the left of the *High Speed Train Frequency Shift Parameters* window display in the grid. The parameters displayed in the right half of the window update based on the entered values.

2.7.2.10 Fixed Delay

To set a path for a Fixed Relative Delay, set the Delay mode to **Fixed** by selecting it from the Delay Mode column. To set the amount of Fixed Relative Delay in microseconds independently for each path, use the Delay Value column.

2.7.2.11 Sliding Delay

The SR5500 allows any number of paths to have Sliding Delay. Set the Delay Mode to **Sliding Delay**, then set the remaining Sliding Delay parameters using the grid directly, or the *Sliding Delay Parameters* window, shown in Figure 2-49. To display the *Sliding Delay Parameters* window, place the mouse cursor in the appropriate row of the Delay Value column and click the **More** button. Make the desired changes to the Sliding Delay parameters and click the **Close** button.

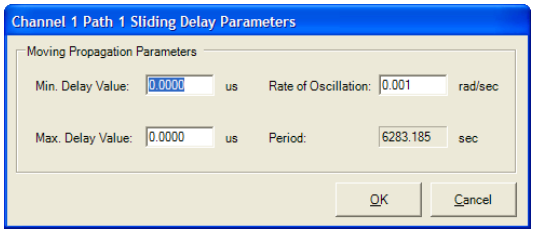


Figure 2-73: Sliding Delay Parameters Window

The Rate of Oscillation (Rate of Osc.) and Delay Period are dependent parameters. Changing one causes the other to reset to the calculated value.

All the parameters presented in the *Sliding Delay Parameters* window also display in the grid. Use the techniques described previously to edit these parameters in the grid.

2.7.2.12 Birth Death Delay

The SR5500 allows any number of paths to have Birth Death Delay. To setup a path for Birth Death Delay, use the Delay Mode column and select **Birth Death**. Click the **Birth Death Settings** button to display the *Channel Birth Death Settings* window.

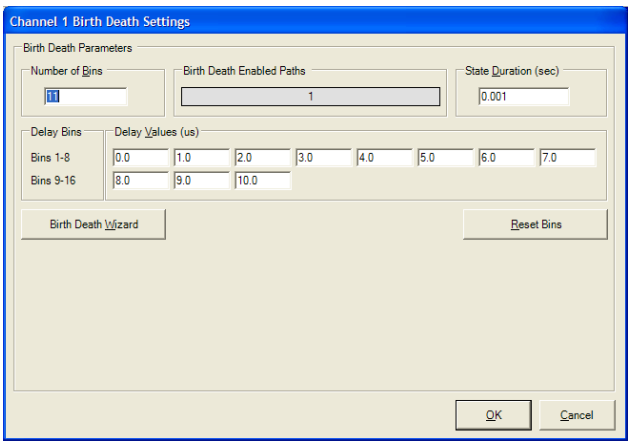


Figure 2-74: Birth Death Settings Window

The Birth Death Wizard allows you to setup the Birth Death parameters. To use the Birth Death Wizard, click the **Birth Death Wizard** button on the lower left of the *Birth Death Settings* window. SR5500 TestKit displays the *Birth Death Wizard* window, as shown in Figure 2-75.

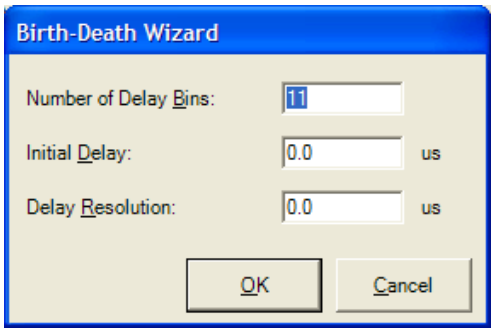


Figure 2-75: Birth Death Settings Wizard

Set the number of delay bins; it should be greater than the number of paths that have Birth Death delay. SR5500 TestKit indicates the paths that have Birth Death delay in the read-only box labeled, *Birth Death Enabled Paths*. The maximum number of delay bins is 64. Set the Initial Delay and the Resolution, or the Increment Delay, and click **OK**.

SR5500 TestKit sets the Birth Death parameters to match your input. You can edit the delay bin values directly. You can reset them all to zero with the **Reset Bins** button. You can also edit the State Duration. To save your changes and close the window, click **OK**. To abandon the changes and close the window, click the **Cancel** button.

2.7.2.13 Relative Path Loss

Each path can have its own relative fixed loss. To set the Relative Path Loss, use the corresponding column.

NOTE: The SR5500 normalizes the power of each path to maintain a composite channel power that equals the Set Output Level. The Path Loss value indicates the path power relative to other paths in the Power Delay Profile.

If only one path is enabled, the Relative Path Loss setting is disabled.

2.7.2.14 Log-Normal Parameters

Each path can have Log-Normal fading enabled. You can also set the Rate and Standard Deviation of Log-Normal.

NOTE: Enabling Log Normal on any path reduces the available output power setting for the channel and degrades system noise and spurious performance. This is due to the additional headroom requirements of Log-Normal. This is true even if the path is not enabled.

2.7.2.15 Power Distribution among Paths

When multiple paths are enabled, the power contributed by each path depends on the Total Number of paths enabled, the Modulation, the Relative Path Loss and state of the AWGN Interferer.

The following tables show the power distribution for some of the typical cases.

Rayleigh Paths				
Pout = 0 dBm	Relative Loss (dB)	Fractional Output Power (Numeric)	Fractional Output Power (dBm)	For Illustration: Power Normalized to Strongest Path power (dB)
Path 1 Rayleigh	0	0.55	-2.6	0
Path 2 Rayleigh	-3	0.275	-5.6	-3
Path 3 Rayleigh	-5	0.174	-7.6	-5
AWGN = Off				

Rayleigh Paths with the 1st Path adjusted to become a Rician with K= 0dB					
Pout = 0 dBm	Relative Loss (dB)	Fractional Output Power (Numeric)	Fractional Output Power (dBm)	For Illustration: Power Normalized to Strongest Path Power (dB)	For Illustration: Power Normalized with Rician / Rayleigh Components Split Out (dB)
Path 1 Rician K=0dB, Direct Power portion	0	0.275	-5.6	0	-3
Path 1 Rayleigh Scattered Power	0	0.275	-5.6	0	-3
Path 2 Rayleigh	-3	0.275	-5.6	-3	-3
Path 3 Rayleigh	-5	0.174	-7.6	-5	-5
AWGN = Off					

Add AWGN to produce a C/N = 10 dB					
Pout = 0 dBm	Relative Loss (dB)	Fractional Output Power (Numeric)	Fractional Output Power (dBm)	For Illustration: Power Normalized to Strongest Path Power (dB)	For Illustration: Power Normalized with Rician / Rayleigh Components Split Out (dB)
Path 1 Rician K=0dB, Direct Power portion	0	0.25	-6.0	0	-3
Path 1 Rayleigh Scattered Power	0	0.25	-6.0	0	-3
Path 2 Rayleigh	-3	0.25	-6.0	-3	-3
Path 3 Rayleigh	-5	0.158	-8.0	-5	-5
AWGN C/N = 10 dB	---	0.0909	-10.4	-7.4	-7.4

2.7.3. Sum of Sinusoids Mode

When Sum of Sinusoids mode is selected, the basis of fading generation is a number of sinusoids summed together with phases, amplitudes, and frequencies defined by the SCM/SCME/WINNER specifications.

Enable the *Sum of Sinusoids* mode from the *System Configuration* window, as shown in Figure 2-76. To access this window, select **Configuration›System/Communication Setup**, or click the System/Communication Setup icon from the toolbar.

NOTE: Sum of Sinusoids Mode is only available in 2X2 MIMO Channel Mode. The MIMO option and GCM option must also be present in the SR5500.

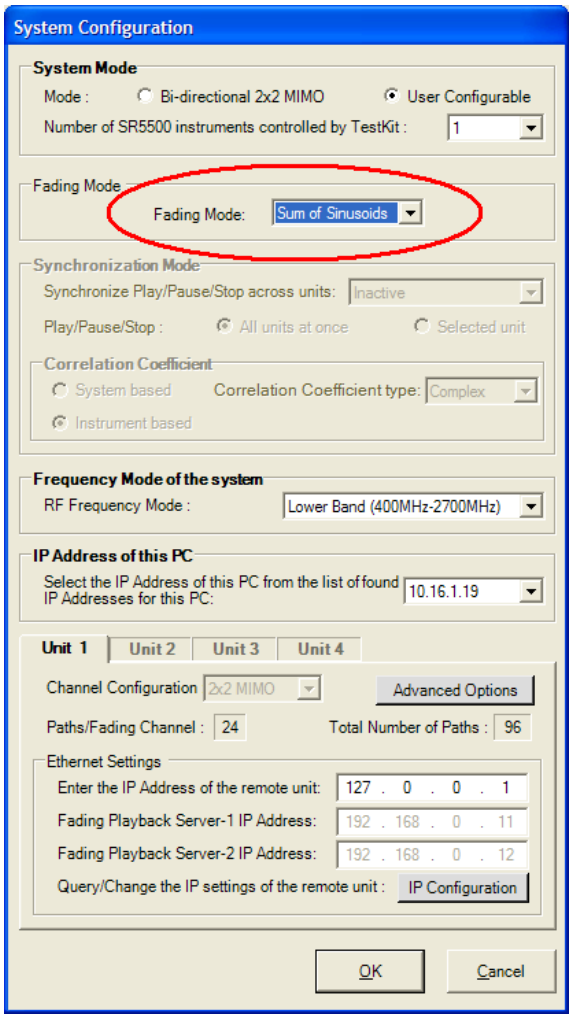


Figure 2-77: System Configuration Window - Sum of Sinusoids Mode

When Sum Of Sinusoids mode is enabled, click **OK** to proceed. The *Channel Editor* window displays, as shown in Figure 2-78 and Figure 2-79 below.

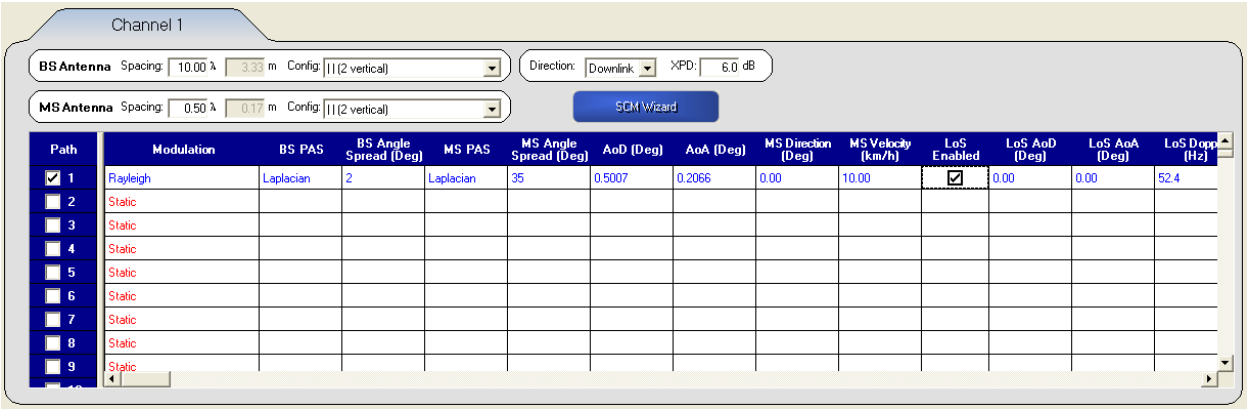


Figure 2-78: Channel Editor - Sum of Sinusoids Mode

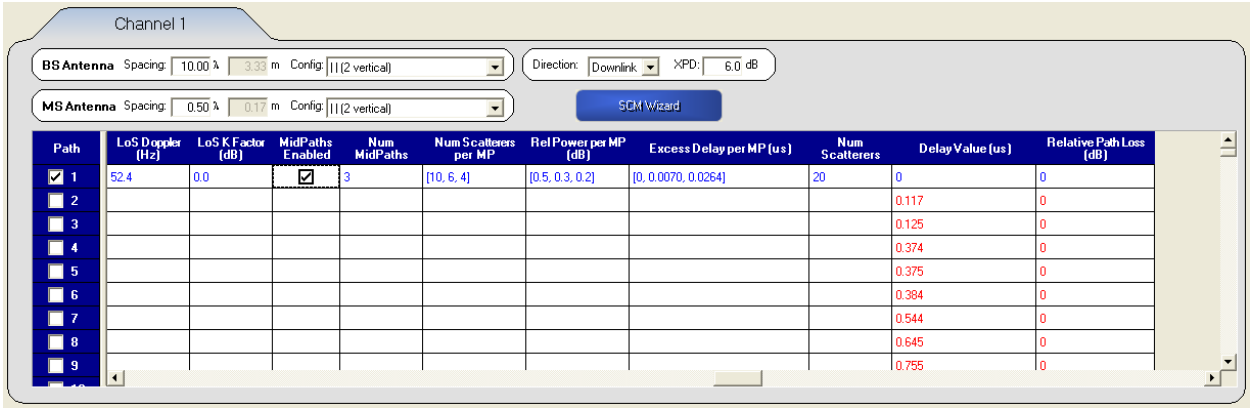

Channel 1
BS Antenna Spacing: 10.00 λ 3.33 m Config: 1 (2 vertical)
Direction: Downlink XPD: 6.0 dB
MS Antenna Spacing: 0.50 λ 0.17 m Config: 1 (2 vertical)
SCM Wizard
Path
LoS Doppler (Hz)
LoS K Factor (dB)
MidPaths Enabled
Num MidPaths
Num Scatterers per MP
Rel Power per MP (dB)
Excess Delay per MP (us)
Num Scatterers
Delay Value (us)
Relative Path Loss (dB)
1 52.4 0.0 3 [10, 6, 4] [0.5, 0.3, 0.2] [0, 0.0070, 0.0264] 20 0 0
2 0.117 0
3 0.125 0
4 0.374 0
5 0.375 0
6 0.384 0
7 0.544 0
8 0.645 0
9 0.755 0

Figure 2-79: Channel Editor - Sum of Sinusoids Mode (continued)

2.7.3.1 Modulation

Sum of Sinusoids Mode supports Static and Rayleigh modulation. Set the modulation type of the path by using the pull-down list in the grid.

2.7.3.2 Number of Sinusoids

This is the number of scatterers per cluster in your environment. Presently, this number is fixed at 20. This value is read-only.

2.7.3.3 LOS Enabled

Allows the addition of a Line of Sight (LOS) path.

2.7.3.4 LOS AOD

The LOS Angle of Departure (AOD) is the Angle of LOS direction between BS and MS, with respect to the broadside of BS antenna array.

2.7.3.5 LOS AOA

The LOS Angle of Arrival (AOA) is the Angle of LOS direction between MS and BS, with respect to the broadside of MS antenna array. This determines the Angle of Arrival of the LOS component.

2.7.3.6 LOS Doppler

This is the component of the Doppler in the LOS direction.

2.7.3.7 LOS K Factor

The K Factor is the ratio of power between the LOS component and the non-LOS (NLOS) components for a path.

The K factor setting has a valid range of -30dB (faded spectrum will dominate) to +30dB (LOS component will dominate).

The power is divided such that the LOS component will have a relative power of K/K+1 and the power of the NLOS components is 1/K+1.

2.7.3.8 AOD

The Angle of Departure (AoD) is defined to be the mean angle with which a departing path's (cluster's) power is transmitted by the BS array with respect to the antenna array broadside. The antenna broadside refers to the direction in which the antenna gain is the highest.

By setting different AoD's for each path, you can model the signal arriving/departing from the BS through clusters at different locations in space.

2.7.3.9 AOA

The Angle of Arrival (AoA) is defined to be the mean angle with which an arriving path's (cluster's) power is received by the MS array with respect to the antenna array broadside.

By setting different AoA's for each path, you can model the signal arriving at the MS from clusters at different locations in space.

2.7.3.10 BS PAS

Defines the Power Azimuth Spectrum at the BS: Laplacian, Gaussian, or Uniform, for a path.

2.7.3.11 BS Angle Spread

This refers to the angle spread of each path at the BS.

2.7.3.12 MS PAS

Defines the Power Azimuth Spectrum at the MS: Laplacian, Gaussian, or Uniform, for a path.

2.7.3.13 MS Angle

This refers to the angle spread of each path at the MS.

NOTE: The higher the Angle Spread, the bigger the cluster from which the signal is arriving/departing. The higher the Angle Spread, the lower is the correlation between channels for a given antenna separation and AoA, AoD.

2.7.3.14 MS Velocity

Defines the Velocity of the MS.

2.7.3.15 MS Direction

Defines the angle of the MS velocity with respect to the MS broadside.

2.7.3.16 Mid-Paths Enabled

Enables mid-paths on the path. Please refer to SCME specification for more information on mid-paths.

2.7.3.17 Number of Mid-paths

When mid-paths is enabled, each path is composed of a number of mid-paths. You can select the number of mid-paths to be 3 or 4.

2.7.3.18 Number of Scatterers per Mid-path

When mid-paths is enabled, each path is composed of a number of mid-paths.

2.7.3.19 Relative Power per Mid-path

This is a read-only field.

Defines the relative power of each mid-path. The sum of mid-path powers for each path will be unity.

2.7.3.20 Excess Delay per Mid-path

Defines how much additional delay (beyond the delay set for the path) each mid-path has.

The maximum delay for each mid-path is 200 microseconds.

2.7.3.21 Delay Mode

Only Fixed Delay Mode is currently available.

2.7.3.22 Delay Value

Defines the delay for the path.

When mid-paths are enabled for a path, the maximum delay for the path is 1999.8 microseconds.

2.7.3.23 Relative Path Loss

Defines the relative power of path compared to path 1.

2.7.3.24 BS Antenna Spacing

Defines the spacing, in wavelengths, of the BS antenna.

You can see a read-only display of the antenna spacing in meters. This depends on the carrier frequency.

2.7.3.25 BS Antenna Config

Defines the polarity of the BS antenna as either parallel vertical antennas, or cross-polarized antenna pairs.

2.7.3.26 MS Antenna Spacing

Defines the spacing, in wavelengths, of the MS antenna.

You can see a read-only display of the antenna spacing in meters. This depends on the carrier frequency.

2.7.3.27 MS Antenna Config

Defines the polarity of the MS antenna as either parallel vertical antennas, or cross-polarized antenna pairs.

2.7.3.28 XPD

Defines the Cross-Polarization Discrimination value for the channel.

2.7.3.29 Signal Direction

Specifies whether Arrival is in the Downlink direction (and Departure is in the Uplink direction) or whether Arrival is in the Uplink direction (and Departure is in the Downlink direction).

2.7.3.30 SCM Wizard

The SCM Wizard allows you to easily create SCM/SCME/WINNER scenarios.

SCM Wizard: Welcome

The SCM Wizard begins with the *Welcome* window, shown in Figure 2-80. Click **Next** to proceed.

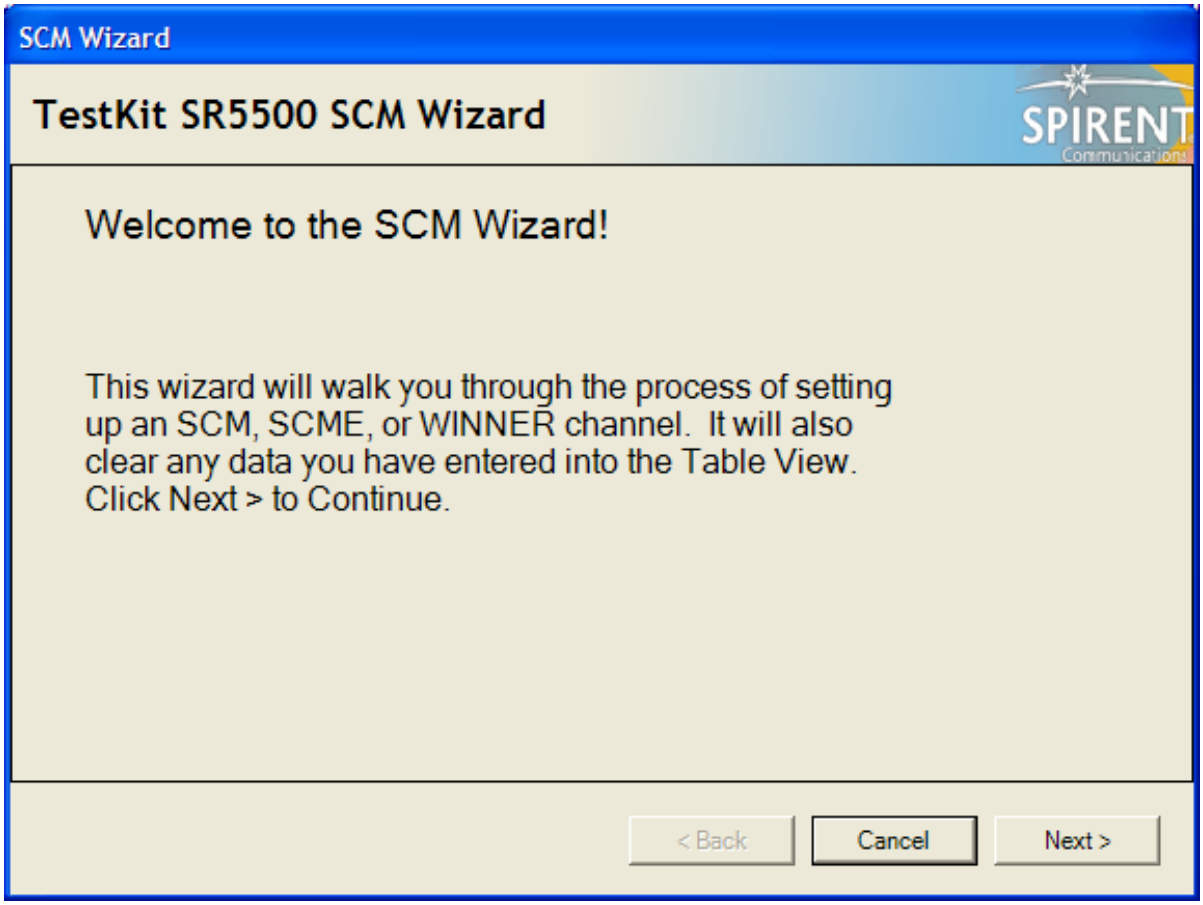

SCM Wizard
TestKit SR5500 SCM Wizard
SPIRENT
Communications
Welcome to the SCM Wizard!
This wizard will walk you through the process of setting up an SCM, SCME, or WINNER channel. It will also clear any data you have entered into the Table View. Click Next > to Continue.
< Back
Cancel
Next >

Figure 2-80: SCM Wizard – Welcome

SCM Wizard: Number of Paths and Mid-paths

The next window allows you to define the Number of Paths used, and if Mid-paths should be defined for a given path. You can define the Number of Mid-paths per Path, and customize the Excess Delay for each mid-path, if necessary, through direct entry in the MidPath Parameters grid. Figure 2-81 shows the *Number of Paths and MidPaths* window.

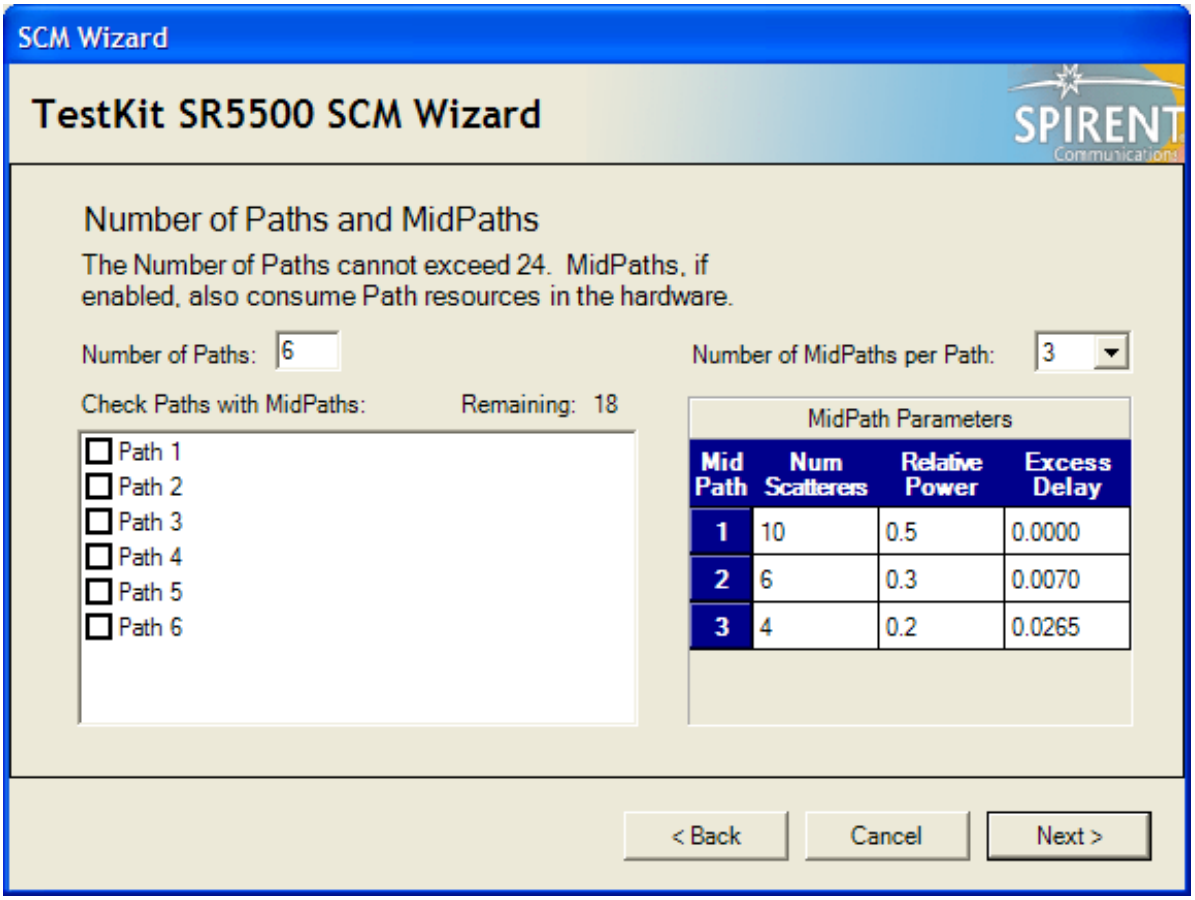


Figure 2-81: SCM Wizard – Number of Paths and MidPaths

SCM Wizard: SCM System Properties

The SCM System Properties window, shown in Figure 2-82, allows you to define the SCM System Properties. These include the Antenna Spacings (in wavelengths), and Signal Direction (Uplink or Downlink).

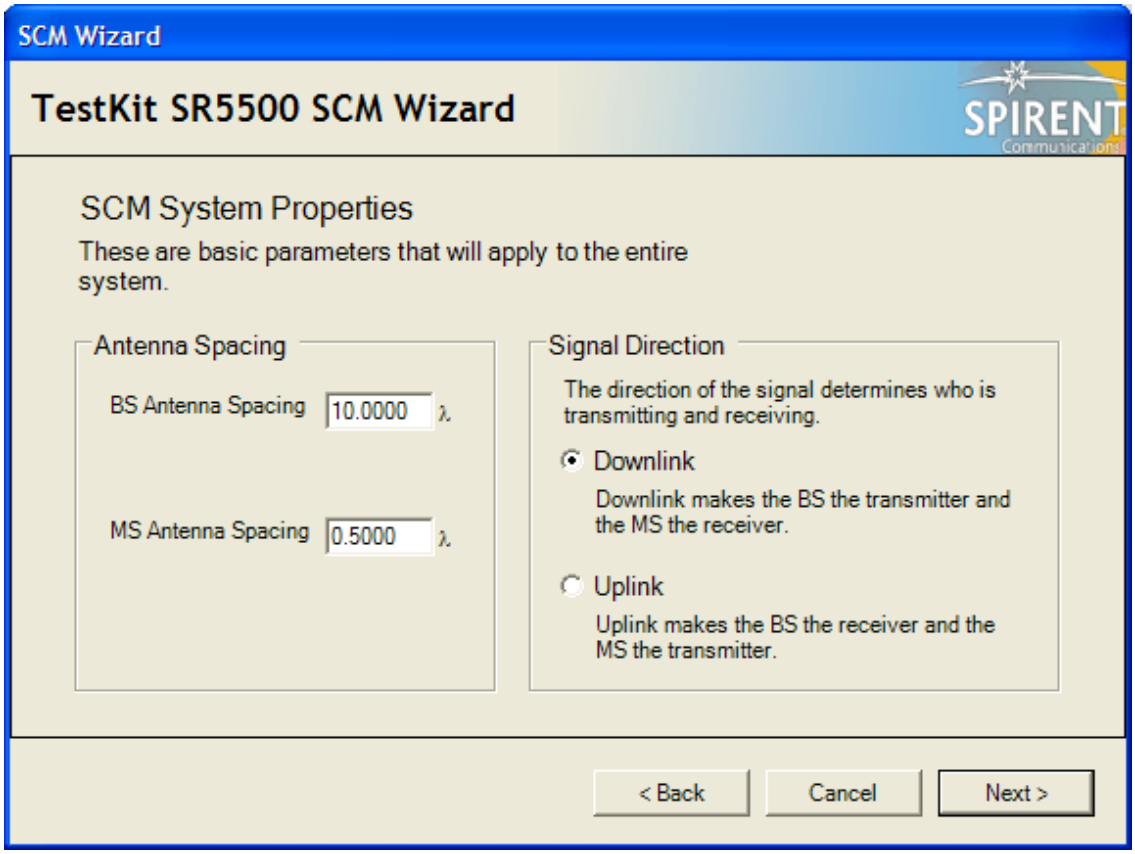


Figure 2-82: SCM Wizard – SCM System Properties

SCM Wizard: Common Path Parameters

The *Common Path Parameters* window, shown in Figure 2-83 , allows you to define the Common Path Parameters, such as PAS at the BS and MS, MS Direction and Velocity, and LOS settings. These are set across all the paths in the model.

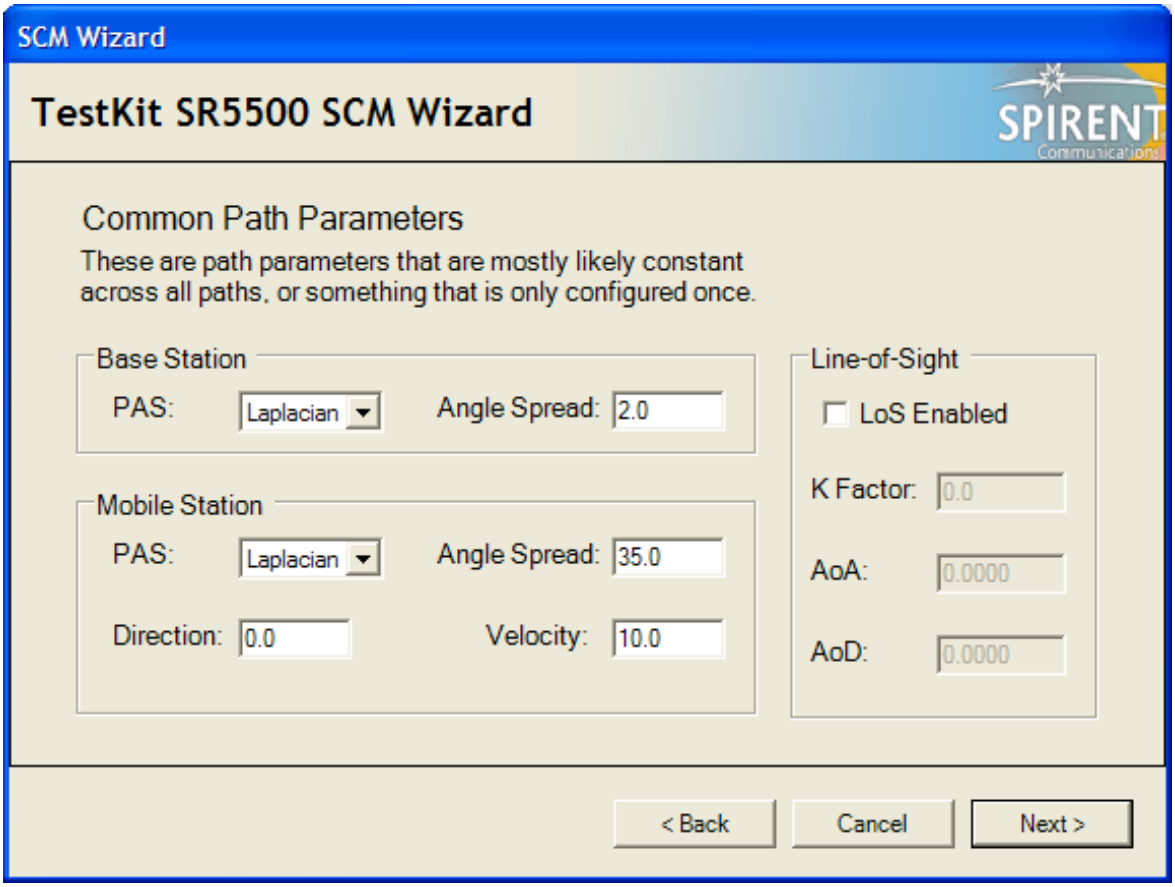


Figure 2-83: SCM Wizard – Common Path Parameters

SCM Wizard: Common Path Parameters

The final window, Common Path Parameters, shown in Figure 2-84, allows you to define individual Path Parameters, such as AOD, AOA, Delay, and Relative Path Loss. Fill-in the table directly to define these parameters for each path.

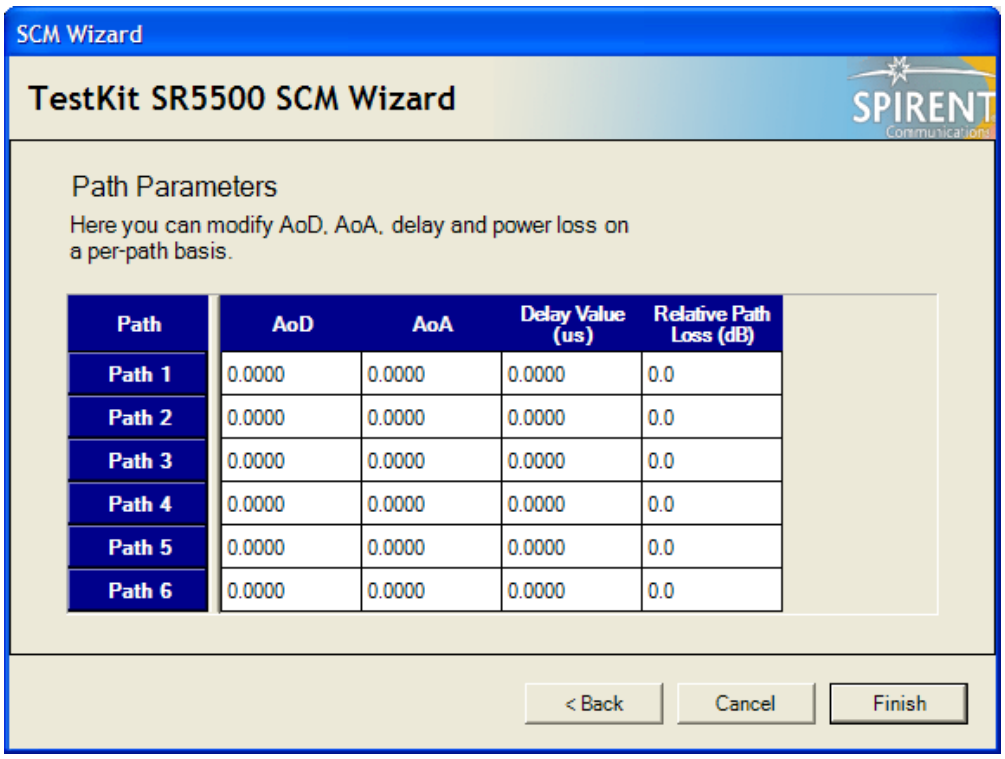


Figure 2-84: SCM Wizard – Path Parameters

When the SCM Wizard is complete, click **Finish** and the model you have built displays in the Channel Editor View, shown in Figure 2-85. You can also make further modifications to the model in the Channel Editor View.

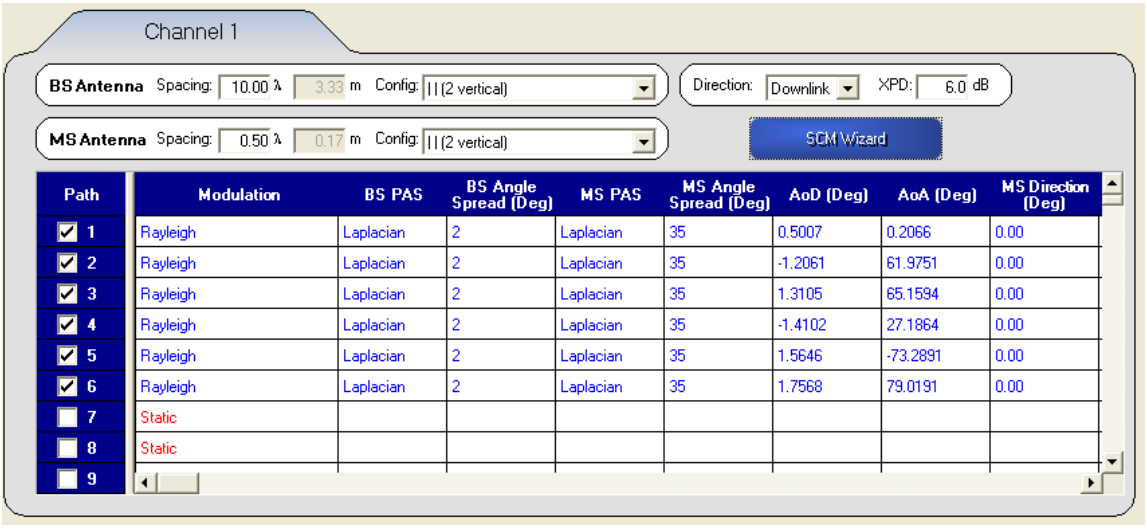

Channel 1
BS Antenna Spacing: 10.00 λ 3.33 m Config: 1 (2 vertical)
Direction: Downlink XPD: 6.0 dB
MS Antenna Spacing: 0.50 λ 0.17 m Config: 1 (2 vertical)
SCM Wizard
Path
Modulation
BS PAS
BS Angle Spread (Deg)
MS PAS
MS Angle Spread (Deg)
AoD (Deg)
AoA (Deg)
MS Direction (Deg)
1 Rayleigh Laplacian 2 Laplacian 35 0.5007 0.2066 0.00
2 Rayleigh Laplacian 2 Laplacian 35 -1.2061 61.9751 0.00
3 Rayleigh Laplacian 2 Laplacian 35 1.3105 65.1594 0.00
4 Rayleigh Laplacian 2 Laplacian 35 -1.4102 27.1864 0.00
5 Rayleigh Laplacian 2 Laplacian 35 1.5646 -73.2891 0.00
6 Rayleigh Laplacian 2 Laplacian 35 1.7568 79.0191 0.00
7 Static
8 Static
9

Figure 2-85: Channel Editor View after Running the SCM Wizard

2.7.4. Interference

The SR5500 is capable of accurately generating and summing Interference into each channel independently. The Interference generated is AWGN at a configurable bandwidth and relative level.

2.7.4.1 Accessing the Interference Editor

Access the *Interference Editor* view by clicking the **Interference Editor** button in the *View Shortcut* window, or by selecting **View›Interference Editor**. The Interference Editor is available for Channel 1 or Channel 2. Select the desired channel by clicking the appropriate tab at the top of the *View* window.

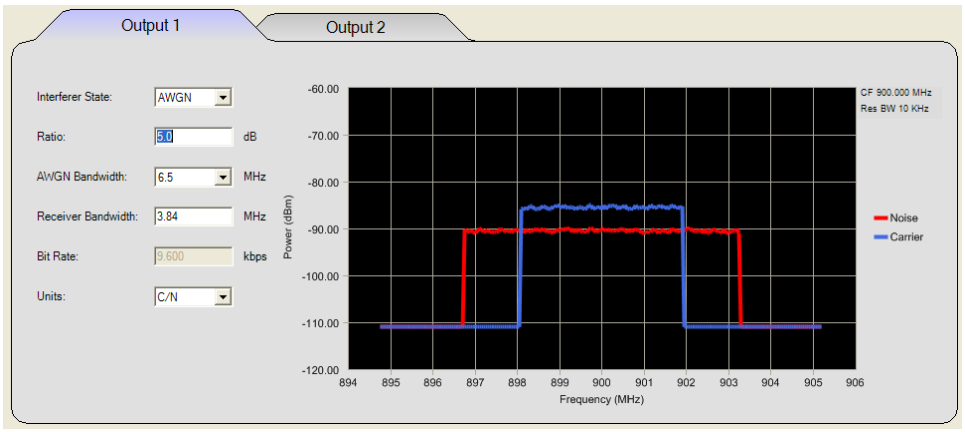


Figure 2-86: Interference Editor - Dual Channel Mode

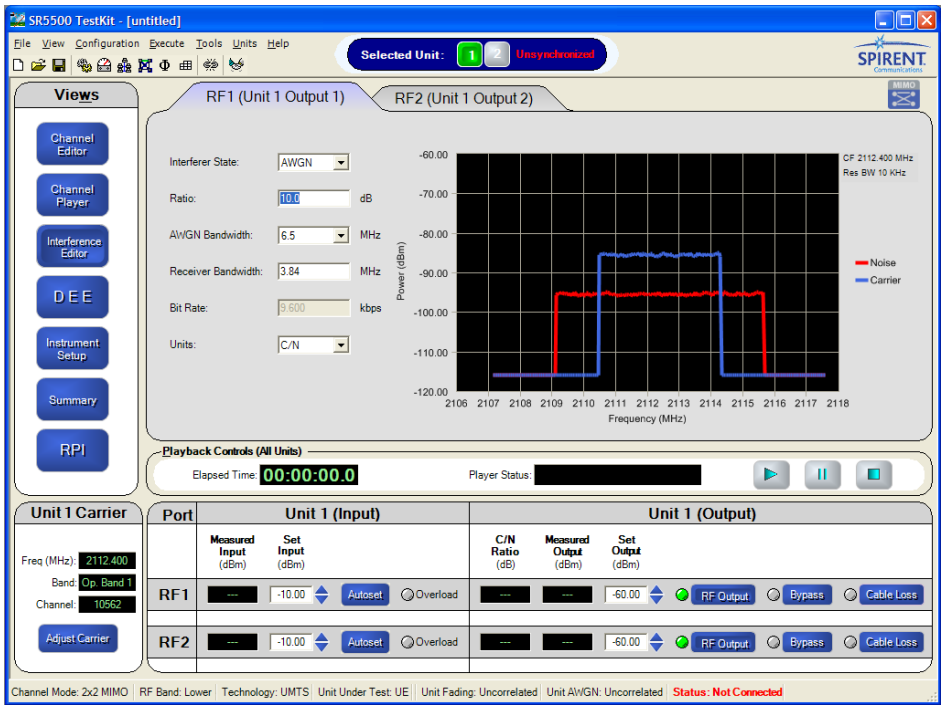


Figure 2-87: Interference Editor - 2x2 MIMO Mode

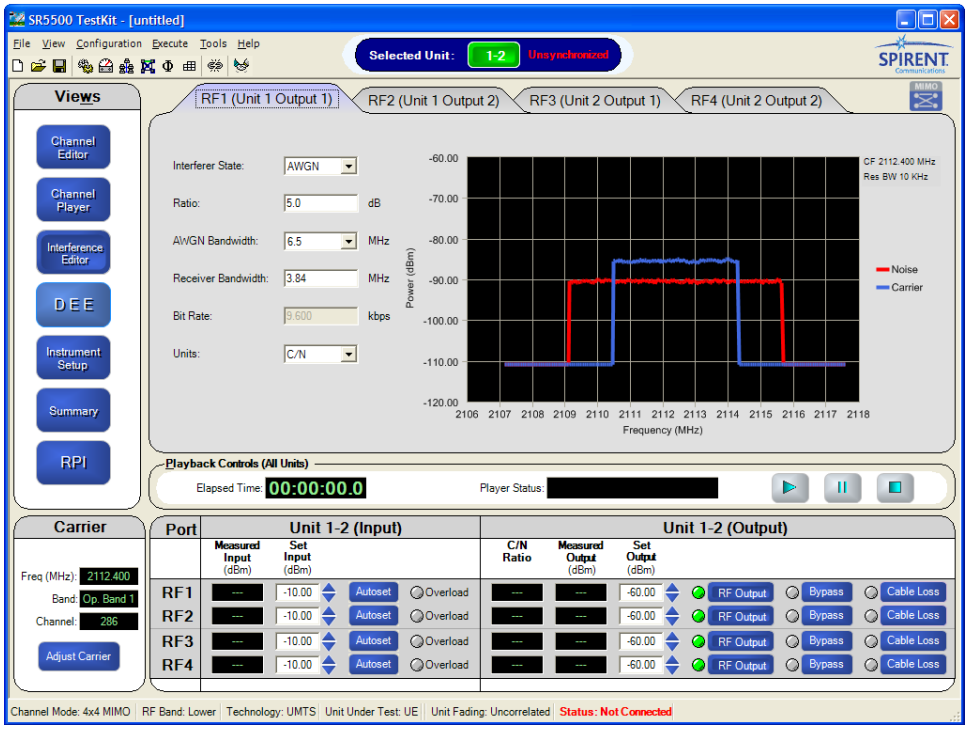


Figure 2-88: Interference Editor - 4x4 MIMO Mode

2.7.4.2 Enabling the Interference

To enable the Interference, select **AWGN** from the Interference State list box.

Figure 2-89: Interference State Setting

NOTE: The Channel Bypass feature overrides the Interference State selection. If the Channel is bypassed, there will be no additive impairments present at the output of the SR5500.

2.7.4.3 Setting the Interference Level

There are three ways to configure the relative level of the interferer to the carrier; C/N, C/No, and Eb/No.

The Ratio parameter specifies the relative power of the interference to the power of the carrier based on the selected units (C/N, C/No, or Eb/No).

Figure 2-90: Ratio Setting

The AWGN Bandwidth parameter specifies the spectral width of the AWGN interference generated from a list box.

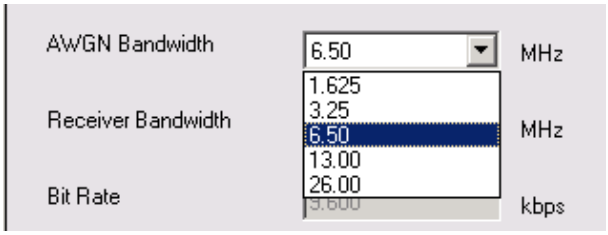


Figure 2-91: AGWN Bandwidth Setting

NOTE: The AWGN bandwidth most be greater or equal to the set Receiver Bandwidth.

The Receiver Bandwidth parameter determines the bandwidth of AWGN interference used when determining the impairment level.

Figure 2-92: Receiver Bandwidth Setting

The Bit Rate parameter used in conjunction with the Interference Level parameters determine the relative level of interference to carrier when using Eb/No units.

Figure 2-93: Bit Rate Setting

Refer to the *Technical Reference* chapter on page 142 for a detailed description of how to set the Interference Relative Level for each of the three units.

NOTE: There are interdependencies between the output power available to the carrier and the output power available to the interferer. Refer to the *Technical Reference* chapter on page 142 for a detailed description of these interdependencies.

2.7.4.4 Spectral Estimate Window

SR5500 TestKit provides a spectral estimate of the Interference and Carrier at the output of the Impairment Channel. The estimate does not take spectral roll-off of the Interference Generator or Carrier Fading into account.

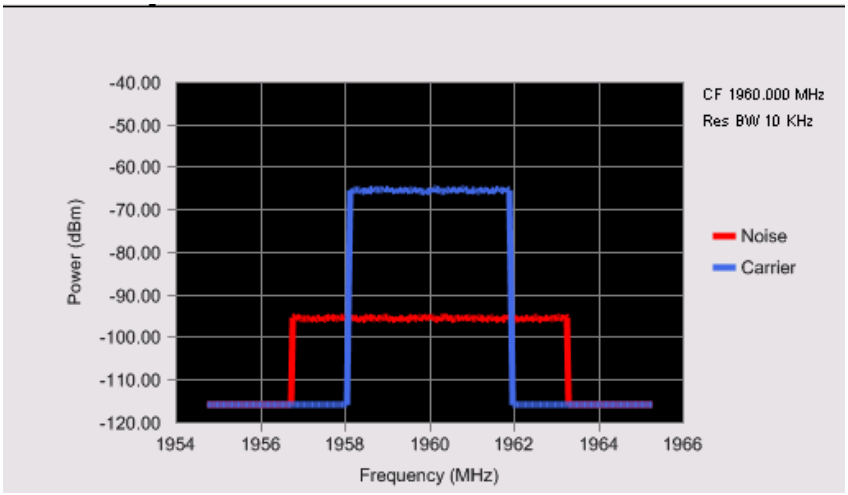


Figure 2-94: Spectral Estimate Window

2.7.5. Instrument Setup View

The SR5500 *Instrument Setup* view is used to setup a number of system level parameters. Rayleigh Fading correlation between channels can be set in this window. Fading correlation is only valid if the path parameters for the different channels match. For example, if the paths on Channel 1 are set to have a Doppler different from Channel 2, the correlation is invalid. An indicator on the status bar informs you if this is the case. When the Correlation Coefficient is set to **System-based**, correlation is unavailable in this window. Refer to the *Controlling Multiple SR5500s* section on page 131 for details.

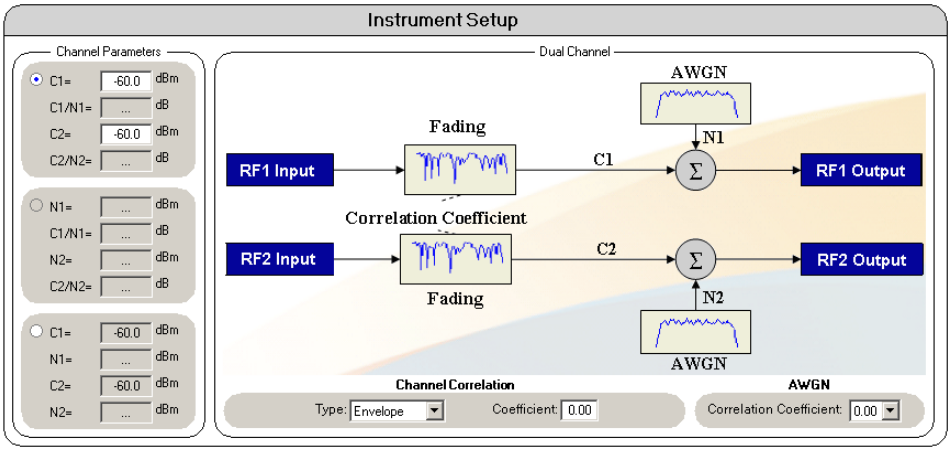


Figure 2-95: System Setup View- Dual Channel Mode

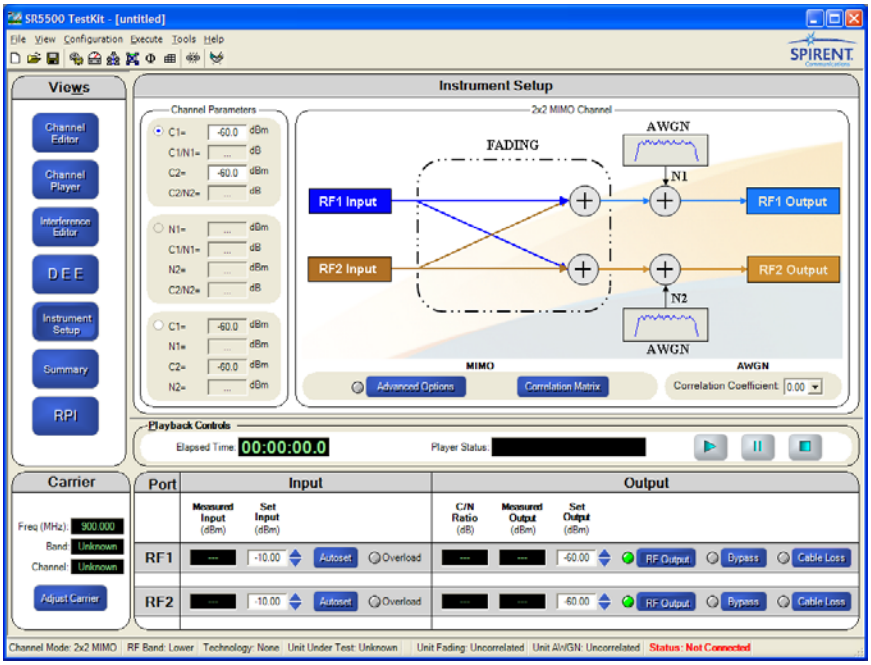


Figure 2-96: System Setup View- 2x2MIMO Mode

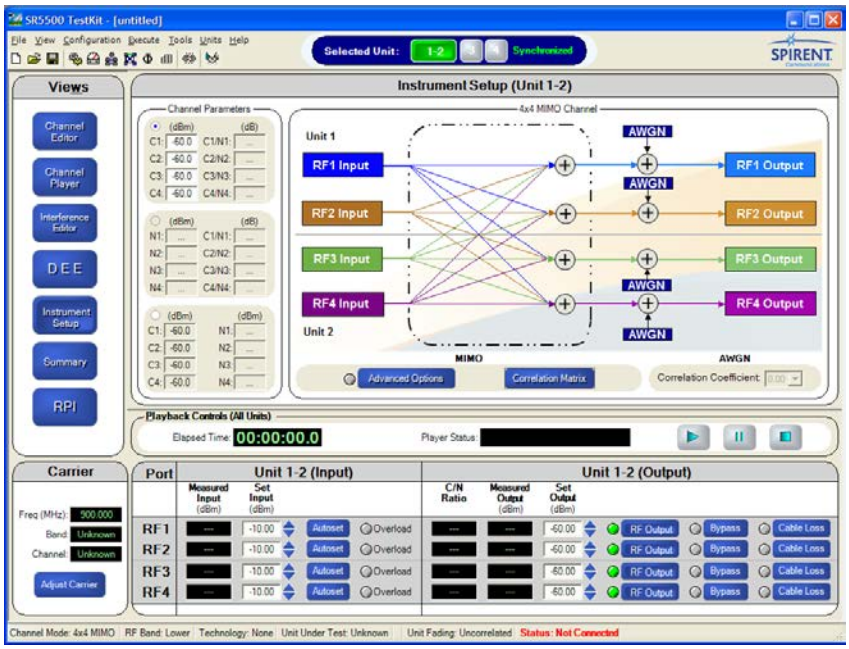


Figure 2-97: System Setup View- 4x4 MIMO Mode

The System Setup view provides other useful functions including a block diagram of the current system setup useful in the RX and TX Diversity modes. Additionally, the Advanced Options button is available in MIMO mode (2x2 and 4x4). This allows you to set advanced MIMO options. When the MIMO options are not set to the default values, the LED to the left of the Advanced Options button turns on. It also allows you to enter the relative power of the carriers and noise inputs in a number of different ways:

Mode 1 – The native mode of the SR5500.

C(Output Power) – Total carrier power at the output of the SR5500. In the case of TX Diversity mode, this is the sum of the power from Carrier 1 and Carrier 2.

C1/C2 – In RX Diversity mode, the ratio of the Carrier 1 power to Carrier 2 power.

C/N – The ratio of the total Carrier power to the Noise power.

Mode 2 – Allows quick translation of C/N ratios from specifications where the Noise power is given, and the Carrier power is derived from a ratio.

N – Total noise power within the receiver bandwidth at the output of the SR5500.

C1/N – Ratio of Carrier 1 to the Noise power.

C2/N – Ratio of Carrier 2 to the Noise power.

Mode 3 – Allows you to set the absolute power of both the carriers and the noise.

N – Total Noise power within the Receiver Bandwidth at the output of the SR5500.

C1– Total power of Carrier 1 at the output of the SR5500.

C2– Total power of Carrier 1 at the output of the SR5500.

2.7.5.1 MIMO Advanced Options

The MIMO *Advanced Options* window allows you to enable or disable the individual MIMO sub-channels. Additionally, you can set the relative gain and phase of the sub-channels

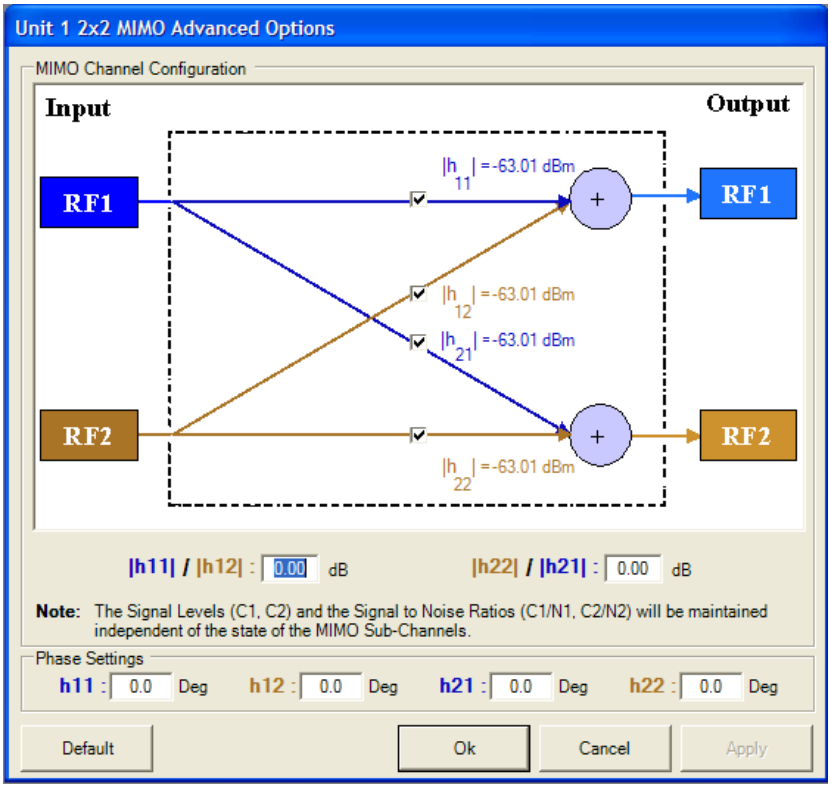


Figure 2-98: System Setup View – 2x2 MIMO Mode

Setting the [h11/h12] ratio sets the power ratio between the channels directed to RF Output 1.

Setting the [h22/h21] ratio sets the power ratio between the channels directed to RF Output 2.

You can also disable the sub-channels by clicking the appropriate checkbox. If a sub-channel is disabled, the output power on the associated RF port is maintained by increasing the power on the other sub-channel. In this case, the power ratio setting is not used.

The Default button sets all values to the defaults. By default, all sub-channels are enabled, the hx1/hx2 ratios are set to 0 dB and the phases are set to 0 degrees.

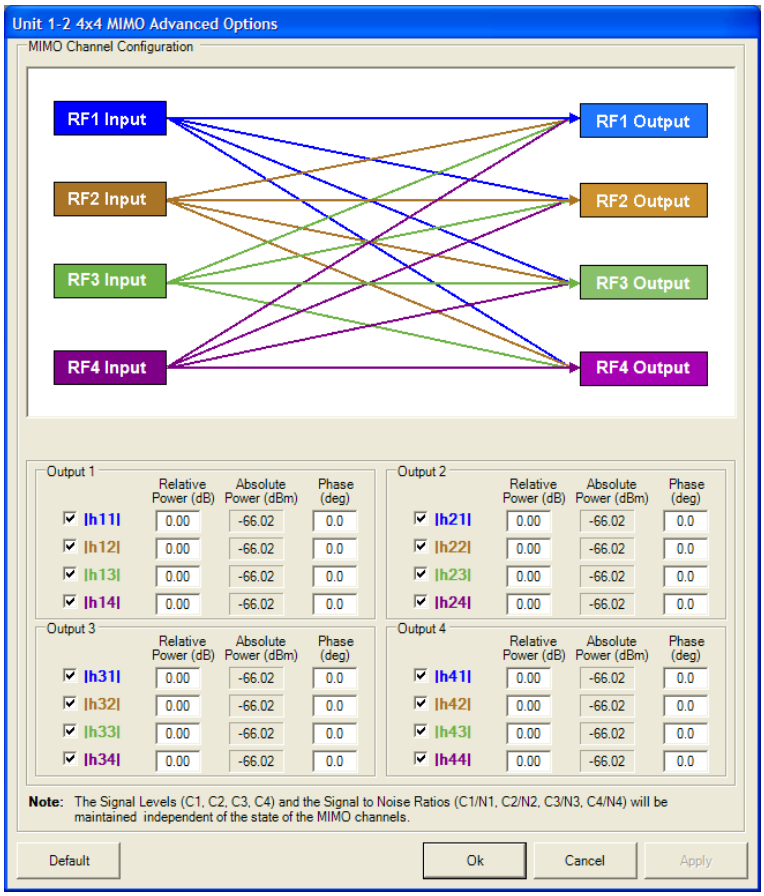


Figure 2-99: System Setup View – 4x4 MIMO Mode

In 4x4 MIMO mode, the relative power for each sub-channel can be set. The window also displays the absolute power for that sub-channel based on the relative power.

If a sub-channel is disabled, the output power on the associated RF port is maintained by increasing the power on the other sub-channels.

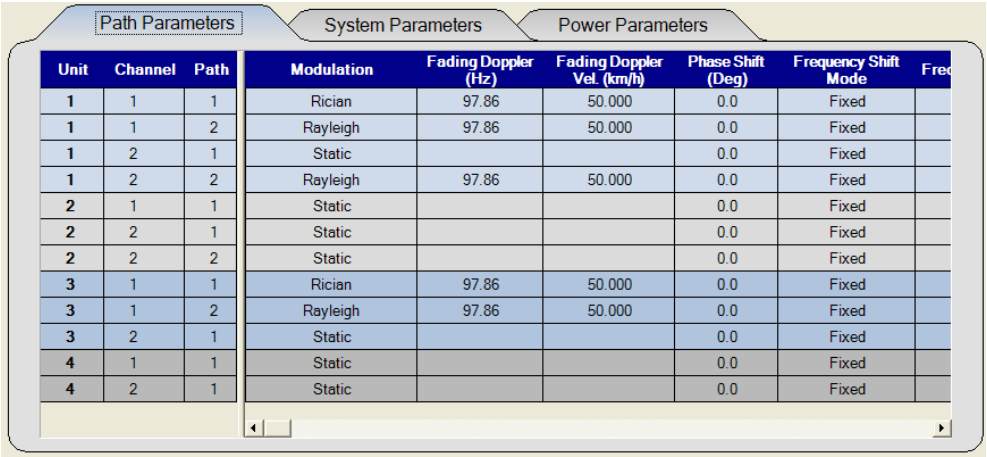
The Default button sets all values to the defaults. By default, all sub-channels are enabled, the Relative Powers are set to 0 dB and the phases are set to 0 degrees.

2.7.6. Summary View

The Summary View allows you to simultaneously view the state of all of the configured units. Access the Summary view by clicking the **Summary** button or by selecting **View›Summary**.

2.7.6.1 Path Parameters

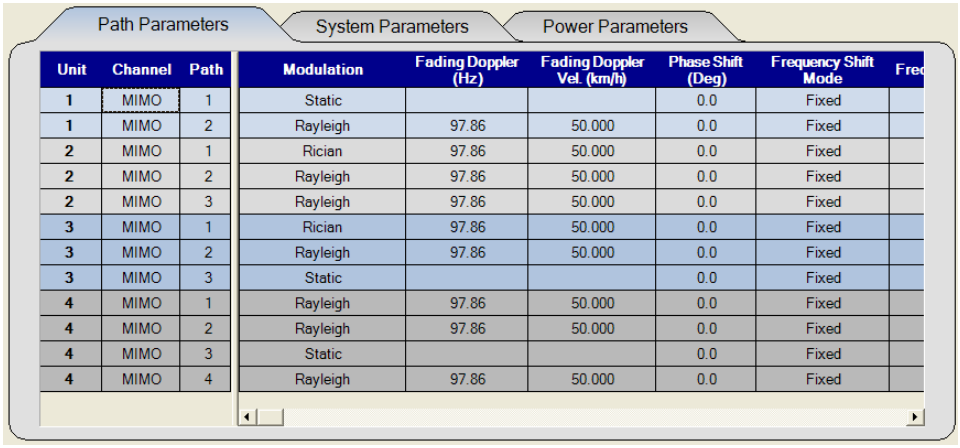
Examine the current state of all configured paths using the **Path Parameters** tab. This tab displays configured paths on all units. Paths that are not enabled do not display in this view. All items are read-only.



Path Parameters | System Parameters | Power Parameters

Unit	Channel	Path	Modulation	Fading Doppler (Hz)	Fading Doppler Vel. (km/h)	Phase Shift (Deg)	Frequency Shift Mode	Fre
1	1	1	Rician	97.86	50.000	0.0	Fixed	
1	1	2	Rayleigh	97.86	50.000	0.0	Fixed	
1	2	1	Static			0.0	Fixed	
1	2	2	Rayleigh	97.86	50.000	0.0	Fixed	
2	1	1	Static			0.0	Fixed	
2	2	1	Static			0.0	Fixed	
2	2	2	Static			0.0	Fixed	
3	1	1	Rician	97.86	50.000	0.0	Fixed	
3	1	2	Rayleigh	97.86	50.000	0.0	Fixed	
3	2	1	Static			0.0	Fixed	
4	1	1	Static			0.0	Fixed	
4	2	1	Static			0.0	Fixed	

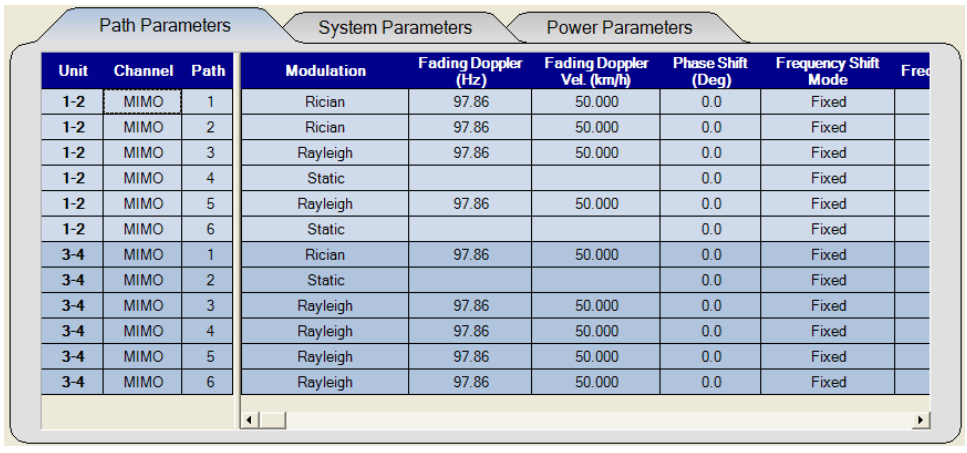
Figure 2-100: Path Parameters View – Dual Channel Mode



Path Parameters | System Parameters | Power Parameters

Unit	Channel	Path	Modulation	Fading Doppler (Hz)	Fading Doppler Vel. (km/h)	Phase Shift (Deg)	Frequency Shift Mode	Fre
1	MIMO	1	Static			0.0	Fixed	
1	MIMO	2	Rayleigh	97.86	50.000	0.0	Fixed	
2	MIMO	1	Rician	97.86	50.000	0.0	Fixed	
2	MIMO	2	Rayleigh	97.86	50.000	0.0	Fixed	
2	MIMO	3	Rayleigh	97.86	50.000	0.0	Fixed	
3	MIMO	1	Rician	97.86	50.000	0.0	Fixed	
3	MIMO	2	Rayleigh	97.86	50.000	0.0	Fixed	
3	MIMO	3	Static			0.0	Fixed	
4	MIMO	1	Rayleigh	97.86	50.000	0.0	Fixed	
4	MIMO	2	Rayleigh	97.86	50.000	0.0	Fixed	
4	MIMO	3	Static			0.0	Fixed	
4	MIMO	4	Rayleigh	97.86	50.000	0.0	Fixed	

Figure 2-101: Path Parameters View – 2x2 MIMO Mode



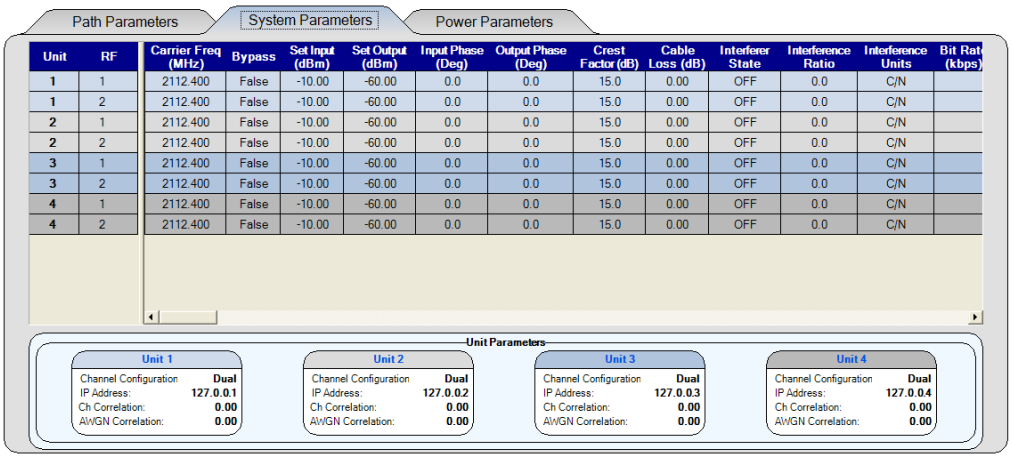
Path Parameters | System Parameters | Power Parameters

Unit	Channel	Path	Modulation	Fading Doppler (Hz)	Fading Doppler Vel. (km/h)	Phase Shift (Deg)	Frequency Shift Mode	Fre
1-2	MIMO	1	Rician	97.86	50.000	0.0	Fixed	
1-2	MIMO	2	Rician	97.86	50.000	0.0	Fixed	
1-2	MIMO	3	Rayleigh	97.86	50.000	0.0	Fixed	
1-2	MIMO	4	Static			0.0	Fixed	
1-2	MIMO	5	Rayleigh	97.86	50.000	0.0	Fixed	
1-2	MIMO	6	Static			0.0	Fixed	
3-4	MIMO	1	Rician	97.86	50.000	0.0	Fixed	
3-4	MIMO	2	Static			0.0	Fixed	
3-4	MIMO	3	Rayleigh	97.86	50.000	0.0	Fixed	
3-4	MIMO	4	Rayleigh	97.86	50.000	0.0	Fixed	
3-4	MIMO	5	Rayleigh	97.86	50.000	0.0	Fixed	
3-4	MIMO	6	Rayleigh	97.86	50.000	0.0	Fixed	

Figure 2-102: Path Parameters View – 4x4 MIMO Mode

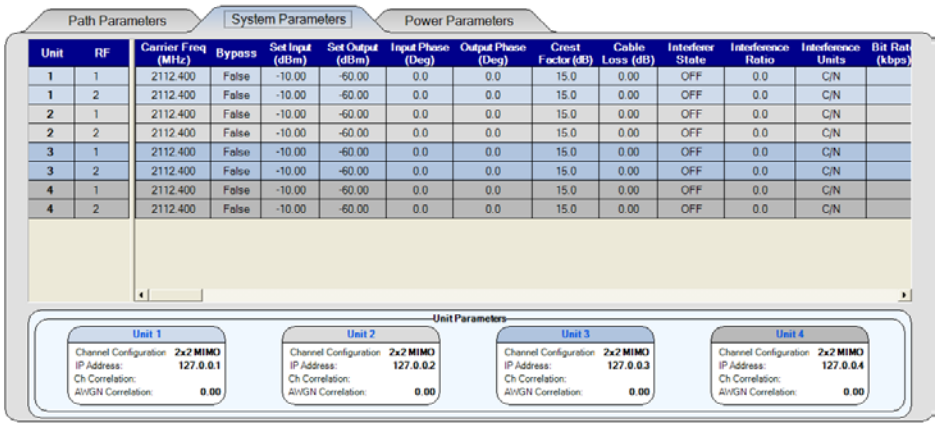
2.7.6.2 System Parameters

Examine the current state of system parameters using the **System Parameters** tab. Items in this view are read-only.



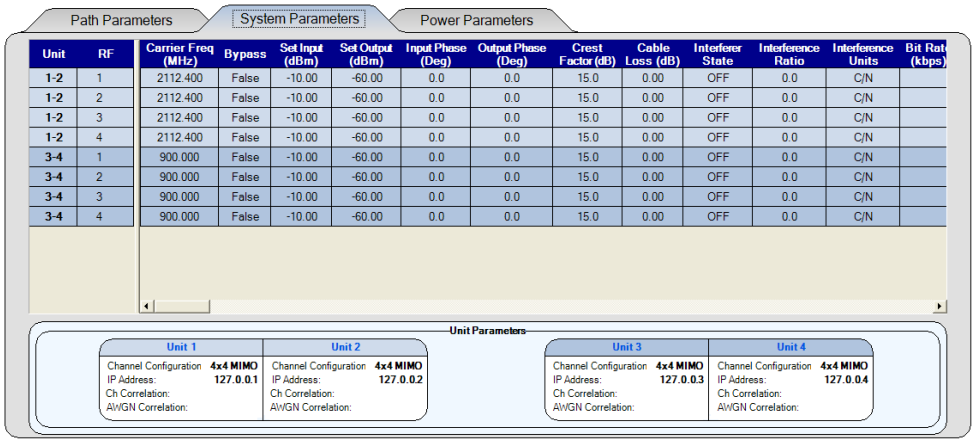
Unit	RF	Carrier Freq (MHz)	Bypass	Set Input (dBm)	Set Output (dBm)	Input Phase (Deg)	Output Phase (Deg)	Crest Factor (dB)	Cable Loss (dB)	Interferer State	Interference Ratio	Interference Units	Bit Rat (kbps)
1	1	2112.400	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
1	2	2112.400	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
2	1	2112.400	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
2	2	2112.400	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
3	1	2112.400	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
3	2	2112.400	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
4	1	2112.400	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
4	2	2112.400	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	

Figure 2-103: System Parameters View — Dual Channel Mode



Unit	RF	Carrier Freq (MHz)	Bypass	Set Input (dBm)	Set Output (dBm)	Input Phase (Deg)	Output Phase (Deg)	Crest Factor (dB)	Cable Loss (dB)	Interferer State	Interference Ratio	Interference Units	Bit Rat (kbps)
1	1	2112.400	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
1	2	2112.400	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
2	1	2112.400	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
2	2	2112.400	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
3	1	2112.400	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
3	2	2112.400	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
4	1	2112.400	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
4	2	2112.400	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	

Figure 2-104: System Parameters View — 2x2 MIMO Mode



Unit	RF	Carrier Freq (MHz)	Bypass	Set Input (dBm)	Set Output (dBm)	Input Phase (Deg)	Output Phase (Deg)	Crest Factor (dB)	Cable Loss (dB)	Interferer State	Interference Ratio	Interference Units	Bit Rat (kbps)
1-2	1	2112.400	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
1-2	2	2112.400	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
1-2	3	2112.400	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
1-2	4	2112.400	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
3-4	1	900.000	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
3-4	2	900.000	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
3-4	3	900.000	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	
3-4	4	900.000	False	-10.00	-60.00	0.0	0.0	15.0	0.00	OFF	0.0	C/N	

Figure 2-105: System Parameters View — 4x4 MIMO Mode

2.7.6.3 Power Parameters

When using multiple units, you can examine the current state of all power parameters using the **Power Parameters** tab, shown in Figure 2-106 and Figure 2-107.

From this tab, you can configure all power-related aspects of the system, including:

- Adjusting the Set Input level and Set Output level for all channels.
- Viewing the current measured Input, Output, and C/N values.
- Performing an Autoset on all channels.
- Bypassing all channels.
- Identifying overload conditions on any channel.

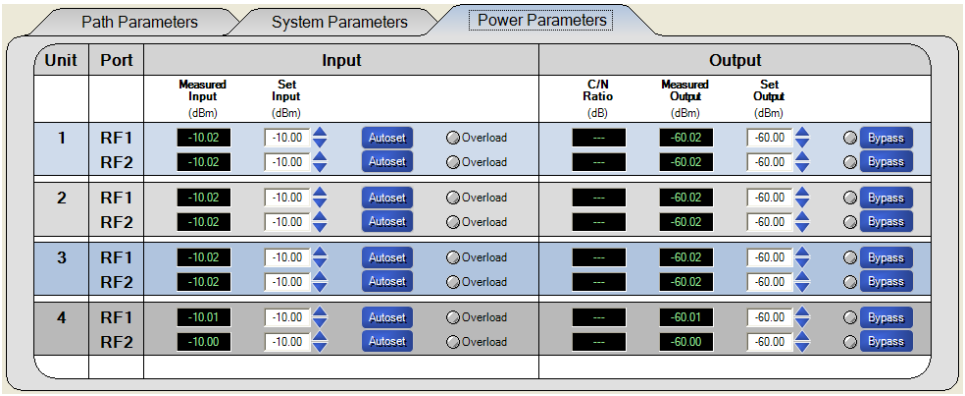

Path Parameters
System Parameters
Power Parameters
Unit
Port
Input
Output
Measured Input (dBm)
Set Input (dBm)
C/N Ratio (dB)
Measured Output (dBm)
Set Output (dBm)
1 RF1 -10.02 -10.00 Autoset Overload --- -60.02 -60.00 Bypass
RF2 -10.02 -10.00 Autoset Overload --- -60.02 -60.00 Bypass
2 RF1 -10.02 -10.00 Autoset Overload --- -60.02 -60.00 Bypass
RF2 -10.02 -10.00 Autoset Overload --- -60.02 -60.00 Bypass
3 RF1 -10.02 -10.00 Autoset Overload --- -60.02 -60.00 Bypass
RF2 -10.02 -10.00 Autoset Overload --- -60.02 -60.00 Bypass
4 RF1 -10.01 -10.00 Autoset Overload --- -60.01 -60.00 Bypass
RF2 -10.00 -10.00 Autoset Overload --- -60.00 -60.00 Bypass

Figure 2-106: Power Parameters View – Dual Channel Mode and 2x2 MIMO Mode

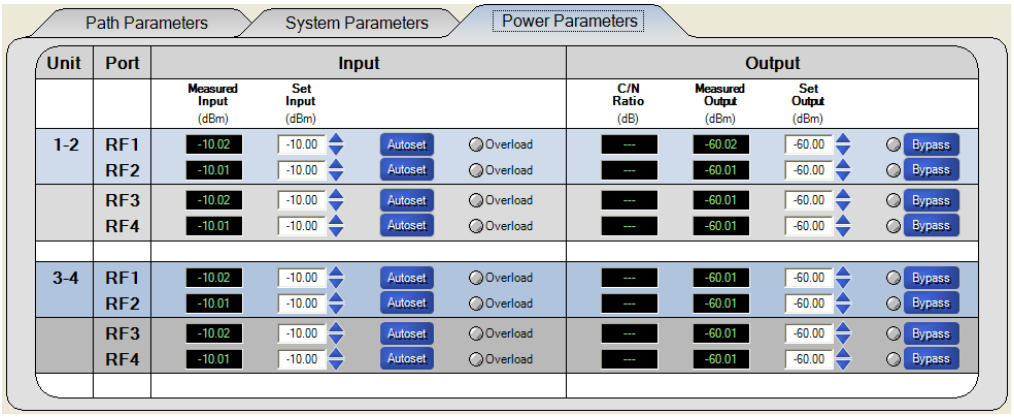

Path Parameters
System Parameters
Power Parameters
Unit
Port
Input
Output
Measured Input (dBm)
Set Input (dBm)
C/N Ratio (dB)
Measured Output (dBm)
Set Output (dBm)
1-2 RF1 -10.02 -10.00 Autoset Overload --- -60.02 -60.00 Bypass
RF2 -10.01 -10.00 Autoset Overload --- -60.01 -60.00 Bypass
RF3 -10.02 -10.00 Autoset Overload --- -60.01 -60.00 Bypass
RF4 -10.01 -10.00 Autoset Overload --- -60.01 -60.00 Bypass
3-4 RF1 -10.02 -10.00 Autoset Overload --- -60.01 -60.00 Bypass
RF2 -10.01 -10.00 Autoset Overload --- -60.01 -60.00 Bypass
RF3 -10.02 -10.00 Autoset Overload --- -60.01 -60.00 Bypass
RF4 -10.01 -10.00 Autoset Overload --- -60.01 -60.00 Bypass

Figure 2-107: Power Parameters View – MIMO 4x4 Mode

2.7.7. SR5078 Switch Control

The SR5500 is capable of controlling the SR5078 Test Switch. This switch is provided with some Spirent Systems products. It is not available for use with a stand-alone SR5500 system. For information concerning the switch operation, consult the documentation provided with the Spirent System.

2.7.7.1 Accessing the SR5078 Test Switch Control

Access the *SR5078 Switch Control* window, shown in Figure 2-108, by selecting **Tools>SR5078 Switch Control** from the main menu.

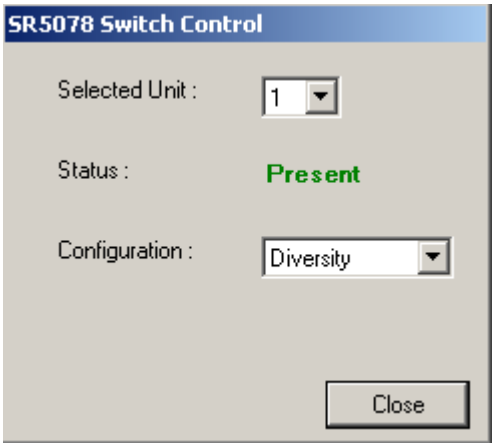


Figure 2-108: SR5078 Switch Control Window

2.7.8. Bi-Directional 2X2 MIMO

Bi-Directional 2X2 MIMO mode is available for seamless control of two SR5500s in a bi-directional 2X2 MIMO configuration. To enable Bi-Directional 2X2 MIMO mode from the *System Configuration* window, select **Bi-Directional 2X2 MIMO** under System Mode, as shown in Figure 2-109.

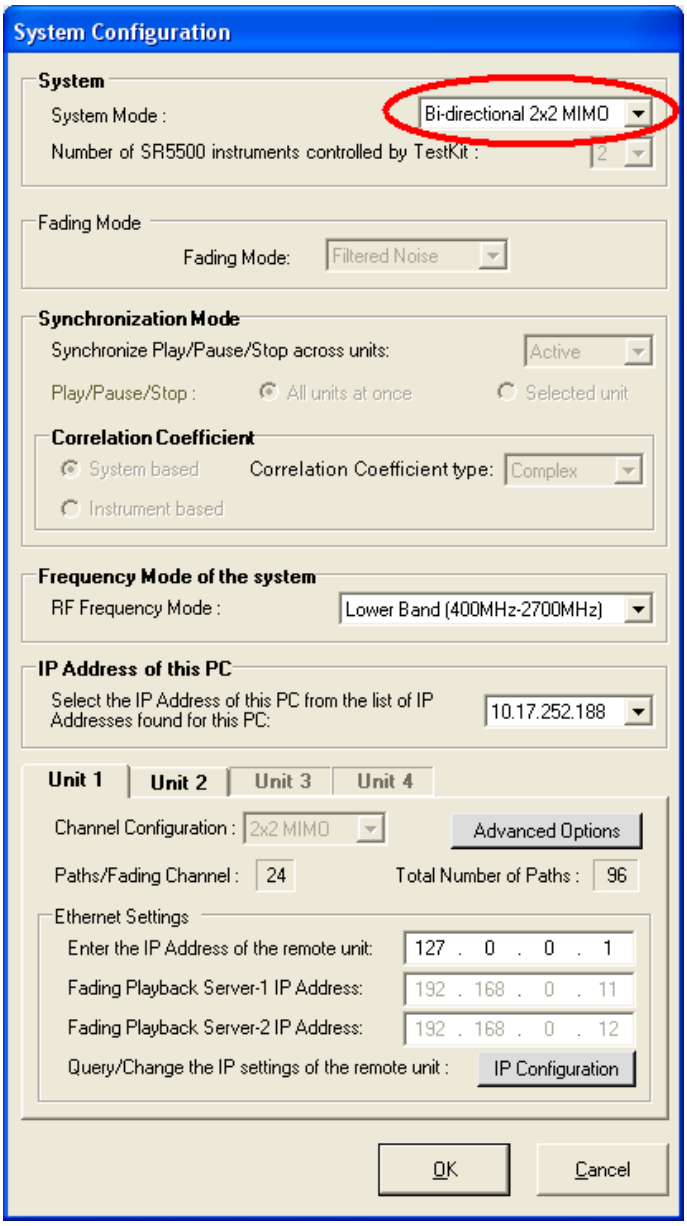


Figure 2-109: System Configuration Window – Bi-directional 2X2 MIMO

Bi-Directional MIMO 2X2 mode is used in Time Division Duplexing (TDD) and Frequency Division Duplexing (FDD) applications. To select TDD or FDD, click the **Advanced Options** button in the *System Configuration* window. The *Advanced Options* window displays, as shown in Figure 2-110.

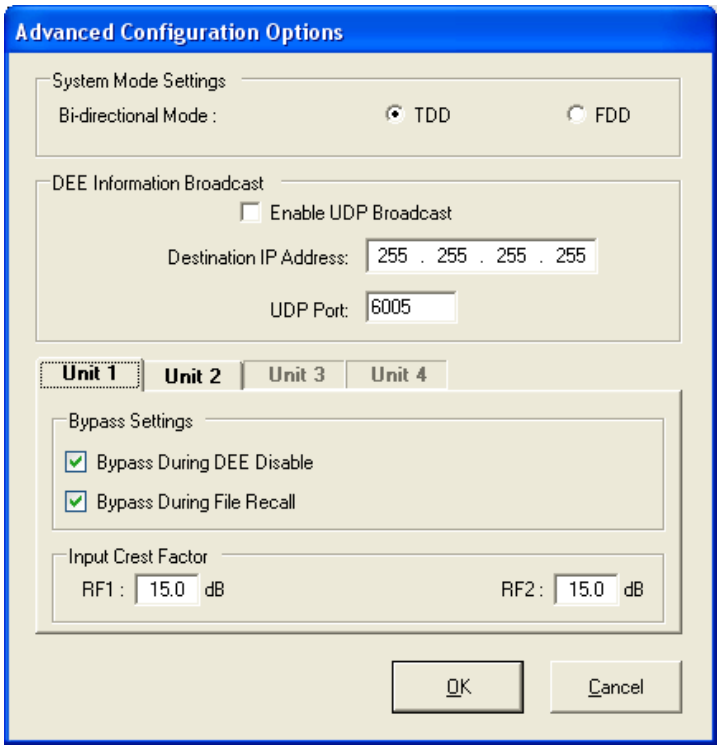


Figure 2-110: Advanced Configuration Options Window

NOTE: For TDD mode, we recommend you use two SR5500 units in conjunction with the RF Interface (RFI) to handle channel isolation between the forward and reverse link.

In both the *Advanced Configurations* and *System Configuration* windows, click **OK** to enter Bi-Directional MIMO 2X2 mode, as shown in Figure 2-111 and Figure 2-112.

The following table identifies the features of Bi-Directional MIMO 2x2 mode.

Bi-Directional MIMO 2X2 Features	
1	Combined Bi-Directional Channel Editor In Bi-Directional MIMO 2X2, both forward and reverse channels share the same Power/Delay Profile and need only be configured through a single table.
2	In Bi-Directional MIMO 2X2 FDD mode, the Carrier Frequency of each unit is set independently. The Unit pull-down list determines what Carrier Frequency, Band, and Channel is being displayed in the Carrier group.
3	Both forward and reverse channel Input and Output characteristics are displayed simultaneously in Bi-Directional MIMO 2X2 mode.
4	Loss Lock is used to "lock in" a fixed amount of loss through the Bi-Directional MIMO 2X2 system. When Loss Lock is pressed, any change to Set Input and/or Set Output is reflected across the system to maintain constant channel loss in both directions.
5	Bi-Directional MIMO 2X2 Channel Player View displays the instantaneous Power Delay Profile all channels (both directions) in a single view.

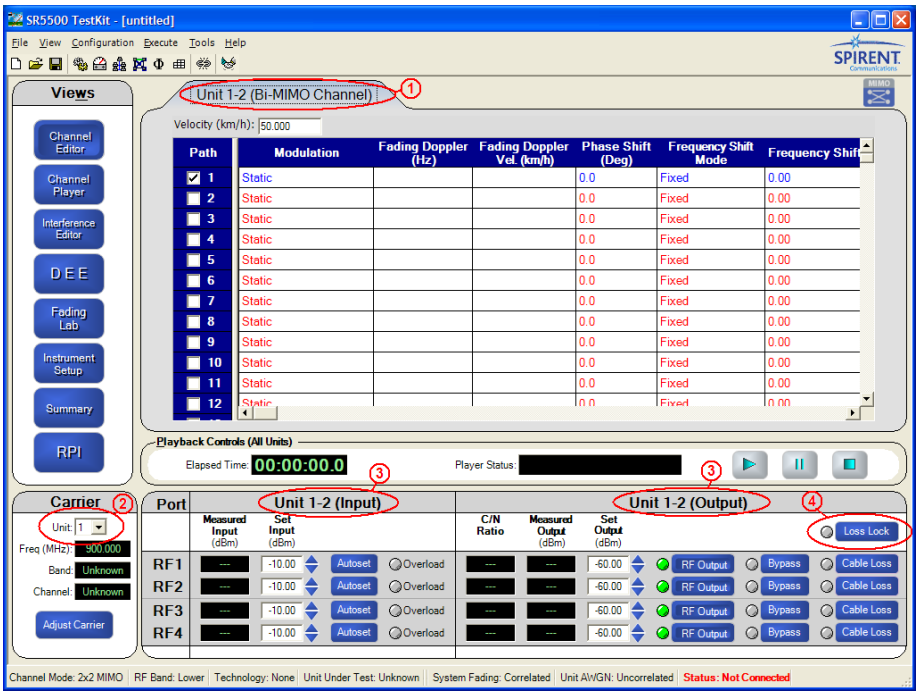


Figure 2-111: Bi-Directional MIMO 2X2 Table View Features

Figure 2-112: Bi-Directional MIMO 2X2 Player View Features

2.7.8.1 Bi-Directional MIMO 2X2 Correlation Reciprocity

In Bi-Directional MIMO 2X2 mode, the correlation reciprocity of the bi-directional channel is handled automatically through the *Correlation* window. Correlation entered in the matrix, shown in Figure 2-113, applies to both forward and reverse channels to ensure that reciprocity is maintained.

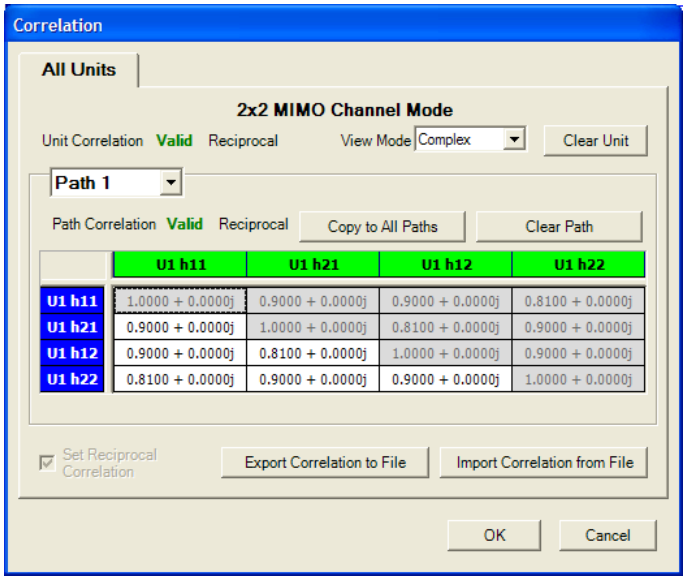

Correlation
All Units
2x2 MIMO Channel Mode
Unit Correlation Valid Reciprocal
View Mode Complex
Clear Unit
Path 1
Path Correlation Valid Reciprocal
Copy to All Paths
Clear Path
U1 h11 U1 h21 U1 h12 U1 h22
U1 h11 1.0000 + 0.0000j 0.9000 + 0.0000j 0.9000 + 0.0000j 0.8100 + 0.0000j
U1 h21 0.9000 + 0.0000j 1.0000 + 0.0000j 0.8100 + 0.0000j 0.9000 + 0.0000j
U1 h12 0.9000 + 0.0000j 0.8100 + 0.0000j 1.0000 + 0.0000j 0.9000 + 0.0000j
U1 h22 0.8100 + 0.0000j 0.9000 + 0.0000j 0.9000 + 0.0000j 1.0000 + 0.0000j
Set Reciprocal Correlation
Export Correlation to File
Import Correlation from File
OK
Cancel

Figure 2-113: Correlation Window

2.8. Dynamic Environment Emulation

This section details the parameters that control the Dynamic Environment Emulation (DEE) function available through the TestKit/SR5500 GUI.

NOTE: Due to the high data rate requirements of DEE, it only functions if there is a direct Ethernet connection between the controller PC and the SR5500, either through a cross-over cable or using a hub. DEE may not function properly over a public network using a router.

NOTE: The DEE feature is not currently available when the channel mode is set to 4x4 MIMO.

The DEE feature allows you to change the state of the SR5500 dynamically at specified time intervals.

You can change the following parameters:

- Channel Output Power
- AWGN Status (ON/OFF)
- C/N Ratio
- Path Status (ON/OFF)
- Path Delay
- Relative Path Loss
- Rician Line of Sight Angle of Arrival
- Rician K Factor
- Frequency Shift
- Doppler Velocity
- MIMO Sub-Channel Status (ON/OFF)
- MIMO Sub-Channel Relative Power
- MIMO Sub-Channel Phase
- Correlation

2.8.1. Method

To create a dynamic profile, you must define the Static State of the SR5500. Set up the static (non DEE) state of the instrument using the TestKit GUI, as you would under normal operation. This information combined with State 1 of the State Emulation file describes the state of the SR5500 in "State 1" of DEE. When the path is initially set to **Off**, you can modify the path parameters. This is allowed so if the path gets turned on dynamically in DEE, the settings for the path are fully defined.

NOTE: While DEE is running, non-DEE parameters cannot be changed.

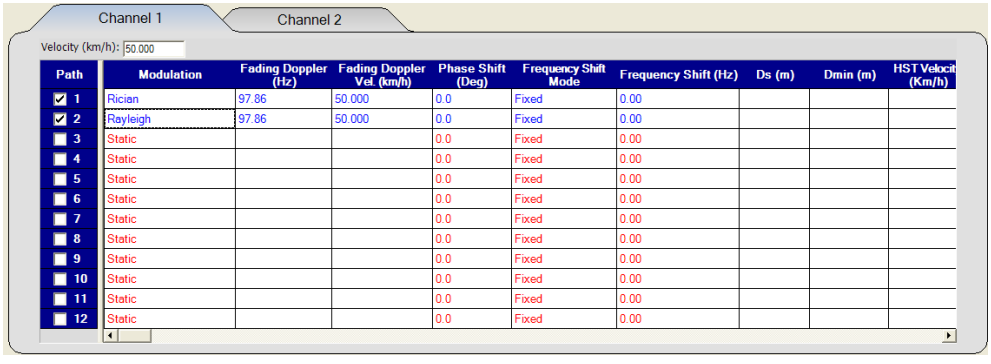


Figure 2-114: TestKit – DEE Parameters

All parameters set up statically in the GUI remain static unless the particular parameter is changed in DEE. Only certain parameters are capable of being changed in DEE. Parameters not controllable in DEE and enabled in the Static Field, such as Modulation, remain enabled during a DEE simulation. The state of the Modulation parameter cannot be changed dynamically and retains its static state.

SPECIAL CASE:

Delay Mode – If the Delay mode for a particular path is set to "Birth/Death or Sliding-Delay", the Delay for that path cannot be changed in DEE. Sliding Delay and Birth/Death operates as set in Static mode while DEE is running.

Frequency Shift Mode – If the Frequency Shift mode for a particular path is set to "High Speed Train", the Frequency Shift for that path cannot be changed in DEE. High Speed Train operates as set in Static mode while DEE is running.

After defining the Static State of the SR5500:

1. Define the **State Changes** in the Emulation file (Refer to page 99 for details). Set up the desired Dynamic Changes using the file **"dee_template.xls"**. This is an Microsoft Excel file used to create the DEE Emulation File. The DEE view provides a shortcut for opening this file.

NOTE: This file needs only to define changes from the static state of the unit. If information in the template is left blank, it is assumed that no change is desired.

2. Export the State Changes to an STB file using the **Export** function in the template. The STB file is a text based file which the GUI can read. This file describes all of the state changes to the GUI.
3. Using the *DEE* view (Refer to page 106) in the main GUI:
   a. Load the **Emulation (STB)** file.
   b. Enable **DEE**.
   c. Play the **Emulation** file.

2.8.2. Emulation File Creation (DEE Template)

The DEE Template defines the changes to the state of the SR5500. To use the template, macros must be enabled in Microsoft Excel.

NOTE: Previous versions of TestKit used a file format called SSX. This was a proprietary XML based format. This format was discontinued with the 2.10 release of TestKit due to inefficient, large file sizes. TestKit still accepts previously created SSX files, but the DEE template no longer creates them. A new text-based format known as an STB file has replaced the SSX file.

2.8.2.1 Accessing the DEE Template

The Emulation File Template is found in the root directory of the TestKit Installation. This is usually **"C:\Program Files\Spirent Communications\SR5500 TestKit\"**. You can also access it by clicking the **New Emulation File** button in the *DEE* view.

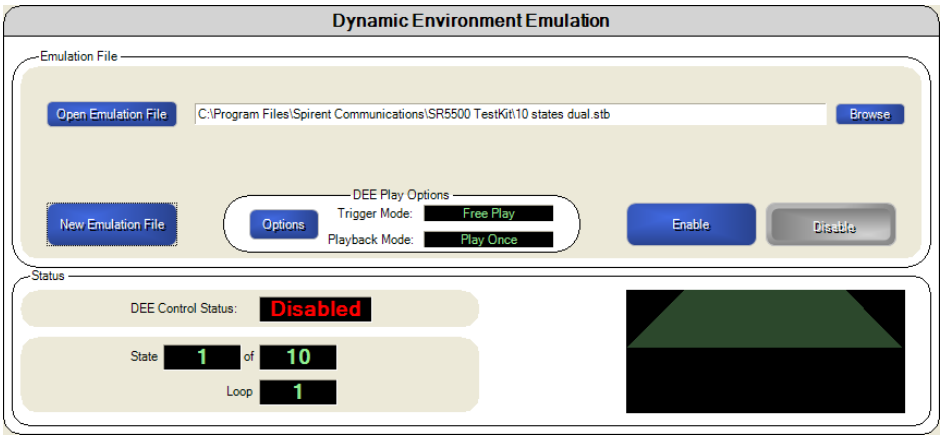


Figure 2-115: Entering the Emulation File Name

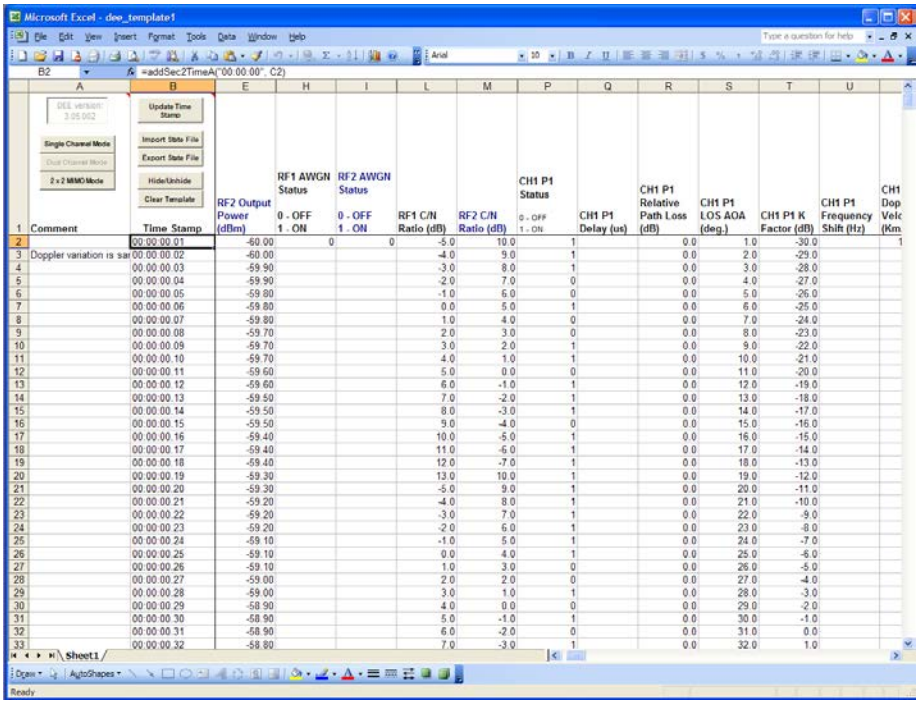

Microsoft Excel - dee_template1
Comment
Time Stamp
RF2 Output Power (dBm)
RF1 AWGN Status 0 - OFF 1 - ON
RF2 AWGN Status 0 - OFF 1 - ON
RF1 C/N Ratio (dB)
RF2 C/N Ratio (dB)
CH1 P1 Status
CH1 P1 Delay (us)
CH1 P1 Relative Path Loss (dB)
CH1 P1 LOS AOA (deg.)
CH1 P1 K Factor (dB)
CH1 P1 Frequency Shift (Hz)
Sheet1

Figure 2-116: DEE Template

2.8.2.2 Editing the Emulation File

The emulation file can be modified using standard Excel methods. A typical Emulation file is shown in Figure 2-116. This file performs the following functions:

In State 1:

1. Set State Duration to **1 second** (each state duration thereafter remains 1 second unless the particular state is changed.
2. Set the output power of the SR5500 to **-60.00**.
3. All other parameters remain as defined in Static mode.

In State 2:

1. Modify the output power of the SR5500.

In State 3:

1. Modify the output power of the SR5500.
2. Turn Channel 1 Path 2 **ON** (1 – ON, 0 – OFF).

In States 4–5:

1. Modify the output power of the SR5500.

In State 6

1. Modify the output power of the SR5500.
2. Turn Path 1 **OFF**. (This path was originally turned on in the Channel Editor table (Static mode).

In States 7-9

1. Modify the output power of the SR5500.
2. Path 1 remains **OFF**.

In State 10

1. Modify the output power of the SR5500.
2. Turn Channel 1, Path 1 **ON**.
3. Change the delay of Channel 1, Path 1 to **3.4 us**.

In States 11-21

1. Modify the output power of the SR5500.

As in the example in Figure 2-117, only changes to the current state are required. If desired, you can enter data when the information has not changed, but it is not necessary.

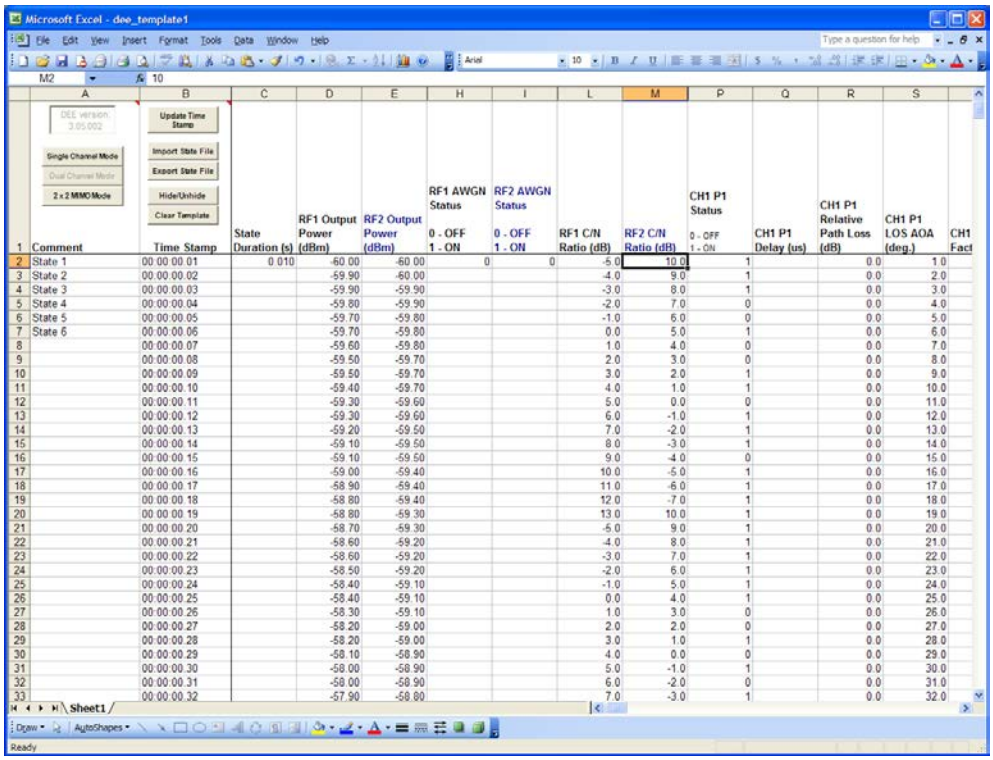

Microsoft Excel - dee_template1
DEE version: 3.05.002
Update Time Stamp
Import State File
Export State File
Hide/Unhide
Clear Template
Single Channel Mode
Dual Channel Mode
2 x 2 MIMO Mode
Comment
Time Stamp
State Duration (s)
RF1 Output Power (dBm)
RF2 Output Power (dBm)
RF1 AWGN Status 0 - OFF 1 - ON
RF2 AWGN Status 0 - OFF 1 - ON
RF1 C/N Ratio (dB)
RF2 C/N Ratio (dB)
CH1 P1 Status 0 - OFF 1 - ON
CH1 P1 Delay (us)
CH1 P1 Relative Path Loss (dB)
CH1 P1 LOS AOA (deg.)
Sheet1

Figure 2-117: DEE Template – Example Changes

NOTE: When exporting a file, if a row is encountered without any data, it is treated as the end of the file. If you want to have a number of states where nothing changes, we suggest you fill in the state duration column for all of these states. The data does not need to change, but it does need to exist.

A	B	C	D	E	H
DEE version: 3.05.002	Update Time Stamp				
Single Channel Mode	Import State File				
Dual Channel Mode	Export State File				
2 x 2 MIMO Mode	Hide/Unhide				
	Clear Template				
Comment	Time Stamp	State Duration (s)	RF1 Output Power (dBm)	RF2 Output Power (dBm)	RF1 AWGN Status 0 - OFF 1 - ON
	00:00:01.00	1.000	-60.00		
			-70.00		
			-80.00		
			-90.00		
			-100.00		

Figure 2-118: Sample –Column with Two States

A	B	C	D	E	H
DEE version: 3.05.002	Update Time Stamp				
Single Channel Mode	Import State File				
Dual Channel Mode	Export State File				
2 x 2 MIMO Mode	Hide/Unhide				
	Clear Template				
Comment	Time Stamp	State Duration (s)	RF1 Output Power (dBm)	RF2 Output Power (dBm)	RF1 AWGN Status 0 - OFF 1 - ON
	00:00:01.00	1.000	-60.00		
		1.000	-70.00		
		1.000			
		1.000	-80.00		
		1.000	-90.00		
		1.000	-100.00		

Figure 2-119: Sample – Column with Six States

2.8.2.3 Setting the Channel Mode

You can set the DEE template for DUAL, SINGLE Channel or 2x2 MIMO Mode. In DUAL mode, the template displays information for Channel 1, Paths 1-12 AND Channel 2, Paths 1-12. In SINGLE Mode, the template displays information for Channel 1, Paths 1-24. In 2x2 MIMO Mode, the template displays information for the MIMO Channel for Paths 1-24 and the MIMO Sub-Channel parameters for h11, h12, h21 and h22.

2.8.2.4 Updating the Timestamps

The Update Timestamp button updates the Timestamp Column. This column is useful when determining how much time it takes to reach state X, especially when the state duration of individual states vary.

2.8.2.5 Copying TestKit to a DEE State

You can copy the current state of SR5500 TestKit to the Windows clipboard and paste the information into a row in the DEE Template. For example, SR5500 TestKit has six paths enabled in Figure 2-120.

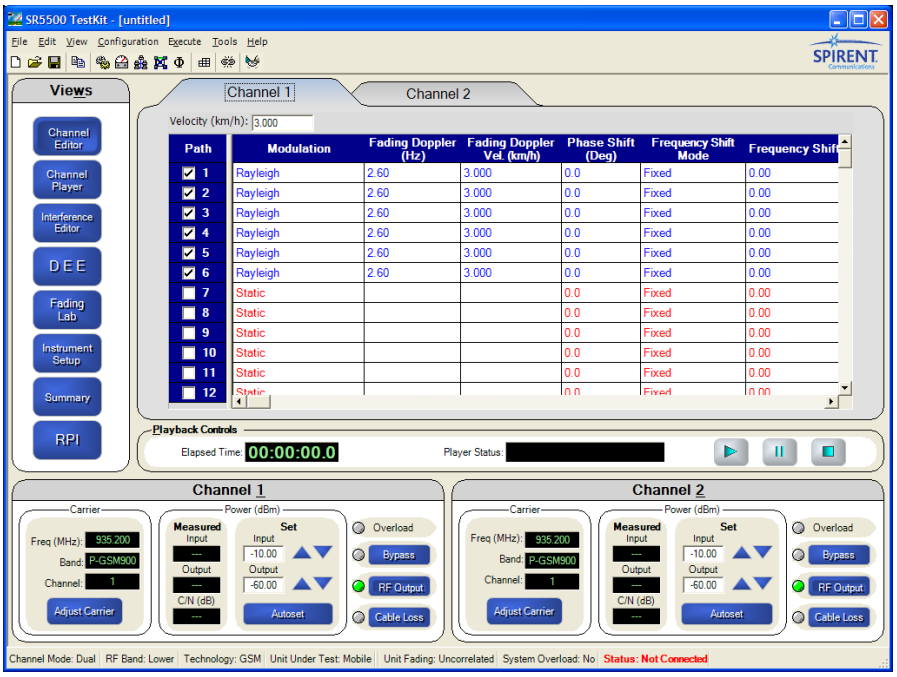


Figure 2-120: Copying a Six Path TestKit Scenario to a DEE State

Click the button, or select **Edit›Copy DEE State Information** from the menu bar. In the DEE Template in Microsoft Excel, select the desired row to copy the state information to, and select **Edit›Paste** as shown in Figure 2-121 below.

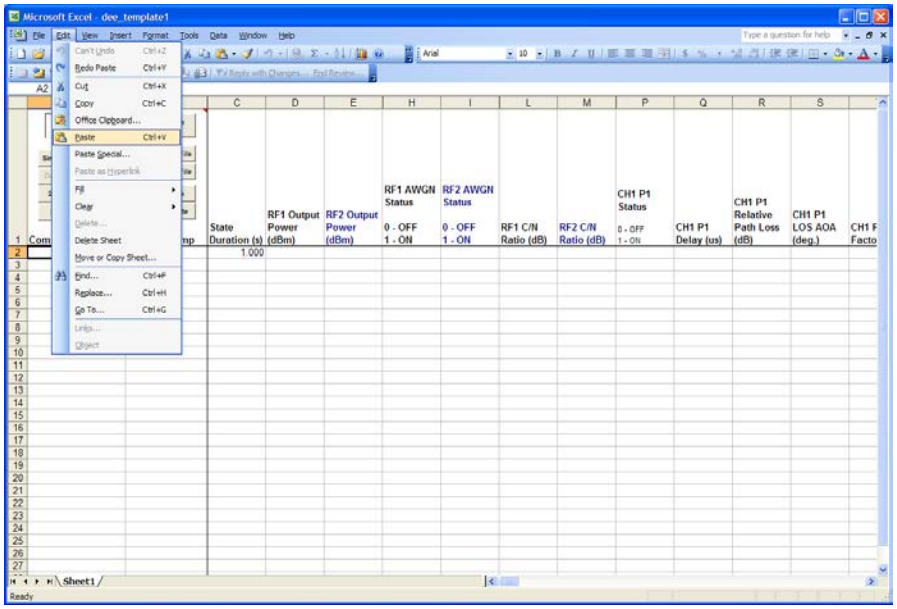


Figure 2-121: Pasting a Six Path TestKit Scenario to a DEE State

Figure 2-122 shows the six-path scenario in State 1 (row 2). This is an excellent way to begin populating a DEE scenario.

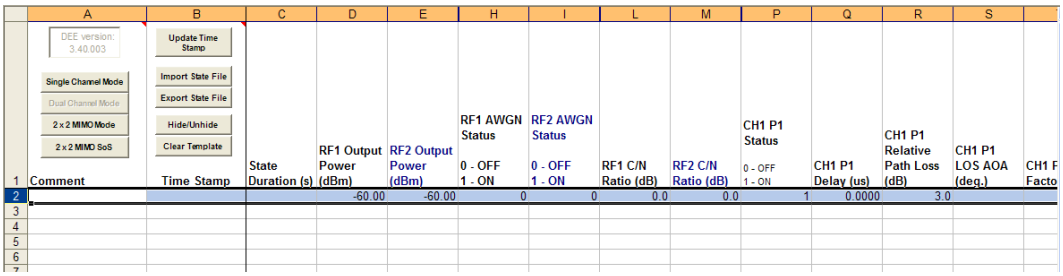


Figure 2-122: State 1 with Six Paths Copied from TestKit

2.8.2.6 Specifying Correlation Files

When you select a cell or cells in the Correlation File column of the DEE template, a small button displays in the first selected row, as shown in Figure 2-123. Click this button to display a standard Windows *Open File* window that allows you to select a correlation file in .CORR format. For more information on creating correlation files, refer to Section 2.14.8: System Correlation.

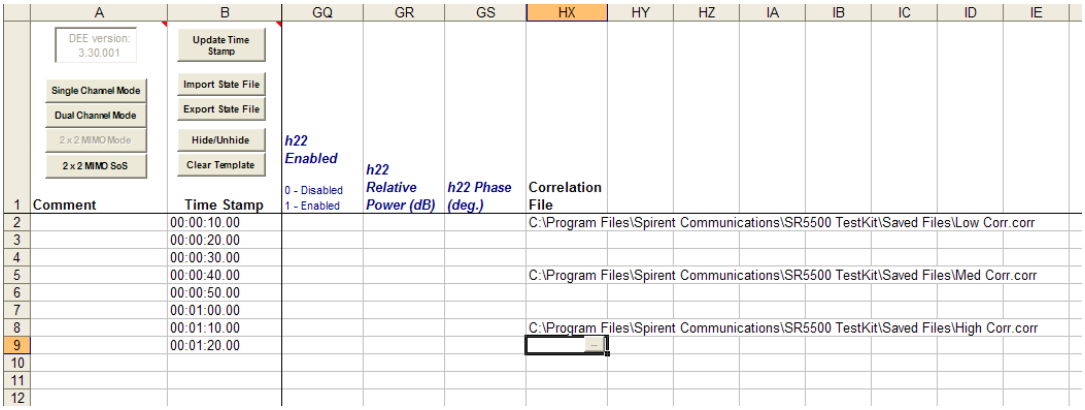


Figure 2-123: Specifying a Correlation Matrix

NOTE: Specifying Correlation matrices is only available in MIMO 2X2 mode. A Complex 4X4 Correlation Matrix is expected at compile time, otherwise, a compiler error will be generated. Envelope and Component correlation matrices is not supported in DEE, however, these can be expressed as an equivalent Complex correlation matrix.

NOTE: Up to 8 unique Correlation matrix files can be specified per DEE template. An error will be generated at compile time if more than 8 matrices are specified.

2.8.2.7 Exporting Files to STB Format

To use the information from the Excel template in DEE, you must export the information to STB format. This is a text based format the TestKit GUI uses to import the state change information. The Export State file button exports the information in the DEE template to a STB state file.

References to correlation files are stored in the STB file as relative paths. This means that as long as the STB and CORR files stay in a fixed relative position, such as in the same folder, they can be moved to different locations on a computer, or even between computers and still be imported and compiled.

2.8.2.8 Importing Files from STB or SSX Format

You can import previously exported STB files and SSX files created with earlier versions of the DEE template using this function. The Import State file button Imports the information in a SSX/STB state file to the DEE template.

2.8.2.9 Modifying the Template View (Hide/Unhide)

The DEE template provides some shortcuts for selectively displaying information associated with a particular Channel or Path. Use the **Hide/Unhide** button to hide or show particular columns, limiting the information displayed to what you want to modify.

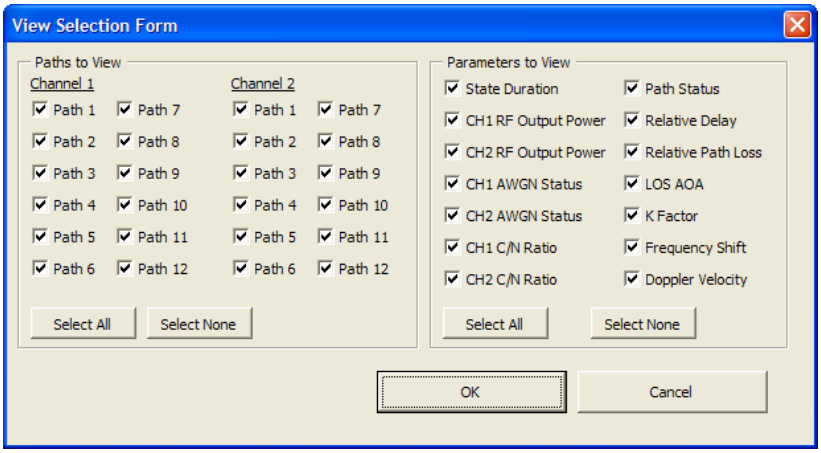


Figure 2-124: View Selection Form Window

2.8.2.10 Clearing the Template

The **Clear Template** button allows you to clear all the data in the spreadsheet.

2.8.3. Dynamic Environment Emulation (DEE) View

The SR5500 is capable of dynamically changing the current state of a number of Path and Channel parameters. These changes can be setup in a table using Microsoft Excel.

2.8.3.1 Accessing the DEE View

Access the DEE view by clicking the **DEE** button in the *View Shortcut* window, or by selecting **View›DEE View**.

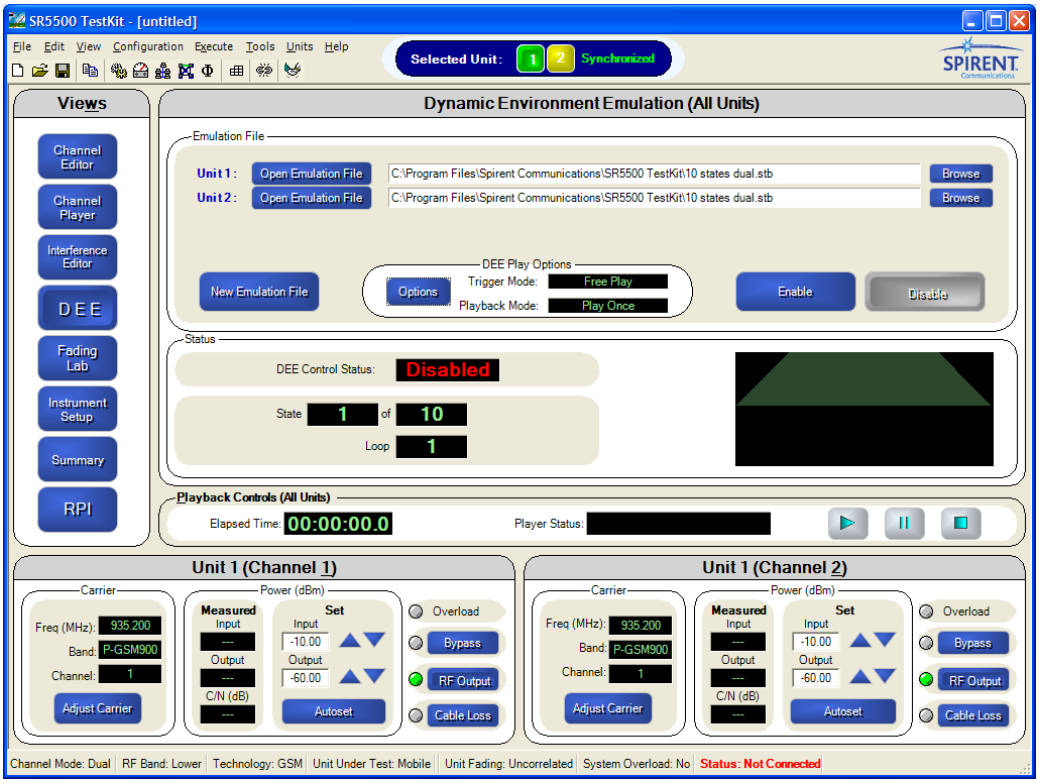


Figure 2-125: Dynamic Environment Emulation (DEE) View

2.8.3.2 Selecting an Emulation File

Select the Emulation file by clicking the **Browse** button. If you are controlling multiple SR5500s, you must select a separate file for each unit. The number of States and the State Durations of the files must match. Refer to Section 2.7.2 on page 98 for further details.

2.8.3.3 Configuring Playback Options

Configure the Playback mode by clicking the **Options** button in the *DEE Play Options* group of the DEE View, as shown in Figure 2-126.

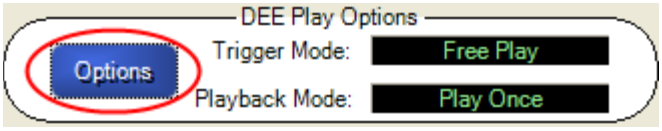


Figure 2-126: Configuring DEE Playback Options

The *DEE Play Options* window displays, as shown in Figure 2-126.

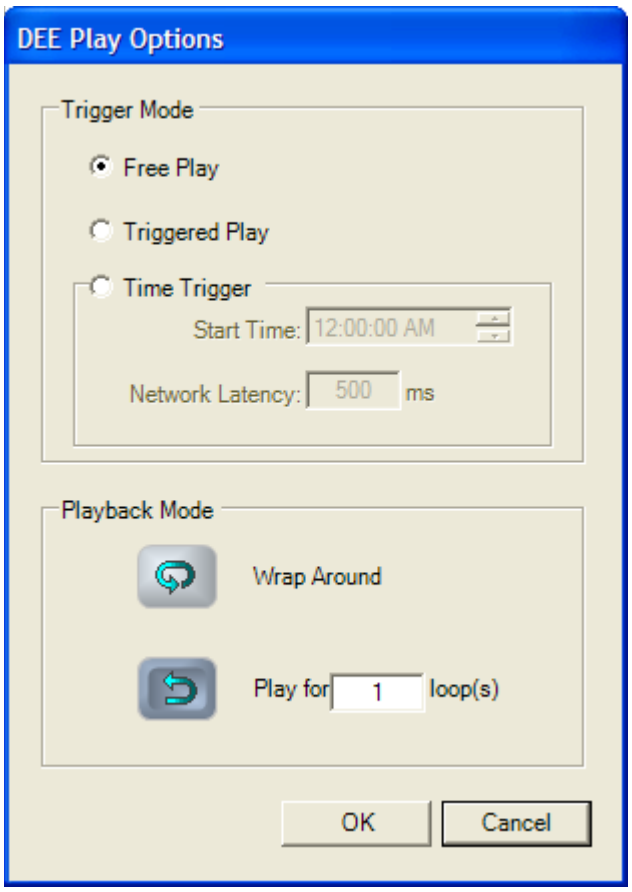


Figure 2-127: DEE Playback Options Window

Select Playback Mode by clicking the **Play for N Loops** or **Wrap Around** button. **Play for N Loops** plays the Emulation file for the specified number of loops to the end of the last loop, resets, and remains stopped at the beginning of State 1 on the next loop. **Wrap Around** continues to loop the Emulation file indefinitely.

NOTE: When the file loops back to State 1, the state of the instrument will be the same as it was the first time in State 1, with the exception that the random number generator creating Rayleigh fading will not reset.

This means that statistically, State 1 will be the same each time DEE loops, but the instantaneous phase and amplitude distortion will differ. This is done to avoid any glitches when wrapping from the last state to the first.

2.8.3.4 Configuring Trigger Mode

Configure the Trigger mode by selecting **Free Run**, **Triggered Play**, or **Timed Trigger** in the Trigger Mode settings. If **Free Run** is selected, the Player starts playing as soon as you click the **Play** button. If **Triggered Play** is selected, the Player waits for an external Trigger after clicking the **Play** button to start playing. Once it gets the trigger, the player starts playing. In **Wrap Around** mode, the player waits for the trigger only for the first loop. The trigger cable should be connected to CH1 TRIG IN. If multiple units are being controlled, the trigger needs to be sent to Unit 1 in Triggered Play mode. Refer to Section 7.6.11.1 for DEE trigger characteristics and trigger signals.

2.8.3.5 Timed Trigger

If Timed Trigger is selected, you can set a Start Time to automatically start playing. You can adjust the Network Latency to account for the time it takes for the play command to traverse the network and DEE to physically start playing.

2.8.3.6 Enabling DEE

DEE Mode can be enabled by clicking on the **Enable** button. When DEE is enabled, the following sequence of events occur:

1. All other views are locked out and you cannot leave the DEE view without first disabling DEE.
2. The software compiles the Emulation file into a machine-readable format. A window opens displaying the status of the DEE compile. If the compile is successful, click the **Enter DEE** button.

NOTE: If you have previously successfully compiled the file, this step is skipped.

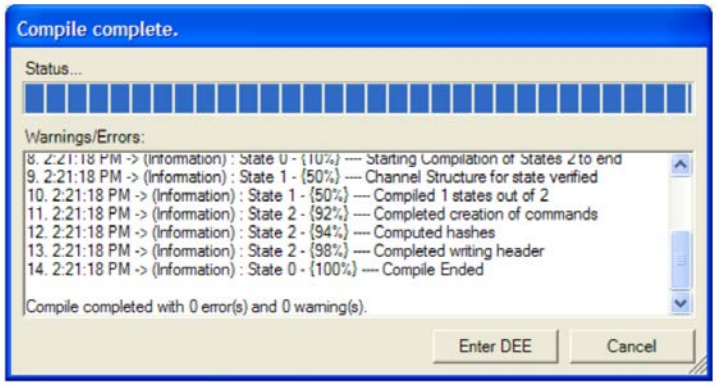

Compile complete.
Status...
Warnings/Errors:
8. 2:21:18 PM -> (Information) : State 0 - {10%} ---- Starting Compilation of States 2 to end
9. 2:21:18 PM -> (Information) : State 1 - {50%} ---- Channel Structure for state verified
10. 2:21:18 PM -> (Information) : State 1 - {50%} ---- Compiled 1 states out of 2
11. 2:21:18 PM -> (Information) : State 2 - {92%} ---- Completed creation of commands
12. 2:21:18 PM -> (Information) : State 2 - {94%} ---- Computed hashes
13. 2:21:18 PM -> (Information) : State 2 - {98%} ---- Completed writing header
14. 2:21:18 PM -> (Information) : State 0 - {100%} ---- Compile Ended
Compile completed with 0 error(s) and 0 warning(s).
Enter DEE
Cancel

Figure 2-128: Compile Status Window

2.8.3.7 Disabling DEE

Disable DEE by clicking the **Disable** button. This stops the DEE engine, restores the instrument to its original state before entering DEE and re-enables access to all TestKit views.

2.8.3.8 Playing (Running) DEE

After enabling DEE, when the player is stopped, there is a single static path from the input to the output with 0s delay; the output powers is set to the power in State 1. When the player starts playing, the path parameters and the output levels vary based on the values for that state. Refer to Section 2.2.2.6 on page 29 for details on how to play, pause, and stop.

When you click the **Play** button , the fading engine begins, and the DEE engine begins cycling through user states.

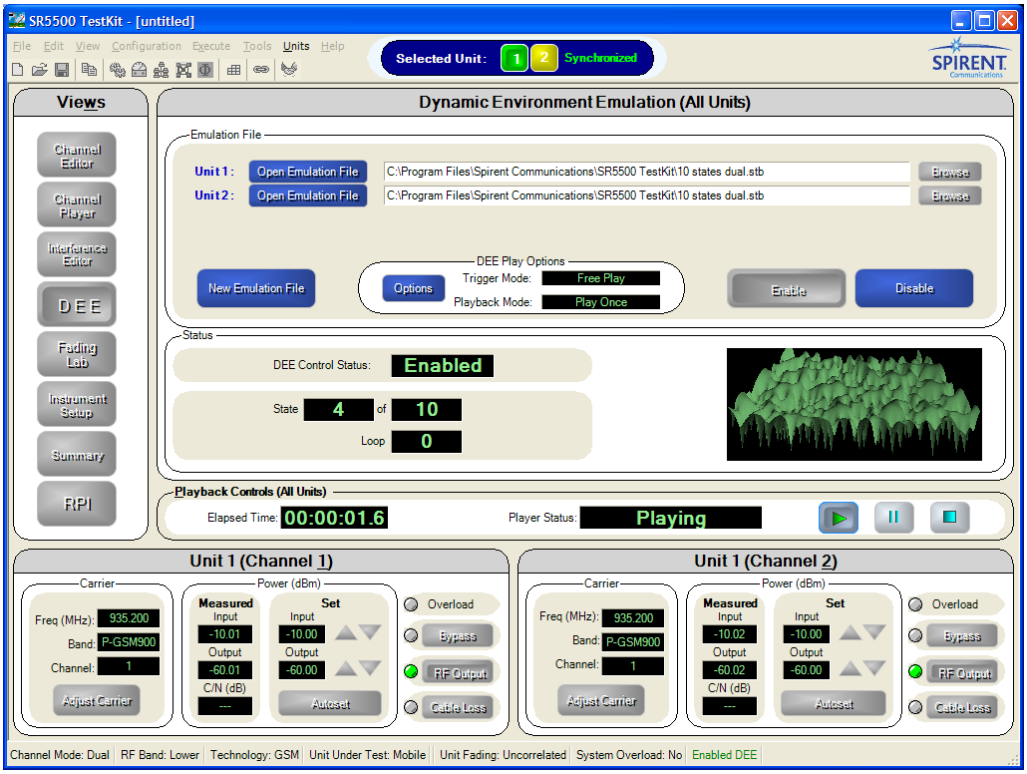


Figure 2-129: Dynamic Environment Emulation (DEE) View- Playing

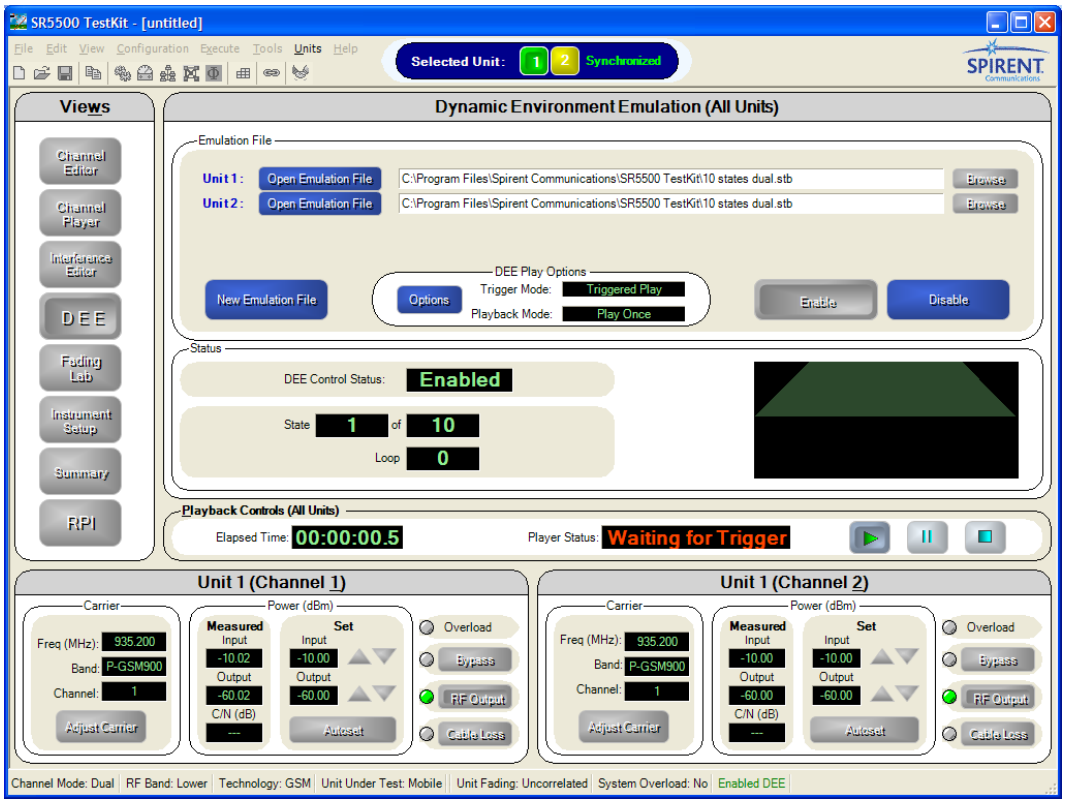


Figure 2-130: Dynamic Environment Emulation (DEE) View- Waiting for Trigger

2.8.3.9 DEE Status Information

The following Information is provided from the DEE engine:

Current State – This is the current state of the DEE engine.

Current Loop – In Play Continuously mode, this indicates how many times the states have been looped.

Total Time – Indicates the total time that DEE has been playing.

Player Status – Indicates the state of the Player – **Playing/Stopped/Paused**.

DEE Animation – A simple animation providing a visual cue that DEE is running. The state of the animation has no effect on the actual PDP of the current state.

Measured Input Level – Shows the constantly measured and displayed input level.

Calculated Output Level – The average output power is calculated and displayed based on the measured input level. The output level measurement assumes a valid path set-up. In an extreme example with all paths turned off, the output power displayed will be incorrect.

Set Output Level – Displays the set output level for the current state.

2.8.4. Using DEE with Multiple SR5500s

TestKit is capable of dynamically changing the current state of Path and Channel parameters simultaneously on up to four SR5500 units. Refer to Section 2.13 on page 131 for more information on multi-unit control.

To run DEE simultaneously on up to four systems, create an STB file for each unit using the Excel template and select the files in the main DEE view.

The STB files for all of the units must have the same number of states. The State Duration is determined from the State Duration information in the STB file for Unit 1. State duration information provided in other STB files is ignored.

2.8.5. Dynamic Correlation in DEE

The SR5500 is capable of time varying correlation in DEE. For example, consider a mobile device moving from a high correlation environment to a low correlation environment over the time span of 60 seconds.

2.8.5.1 Generating Correlation Matrices for use in DEE

Select **Configuration›Correlation Coefficient** from the pull-down menu, or click the icon from the tool bar to access the *Dynamic Correlation* window, as shown in Figure 2-131.

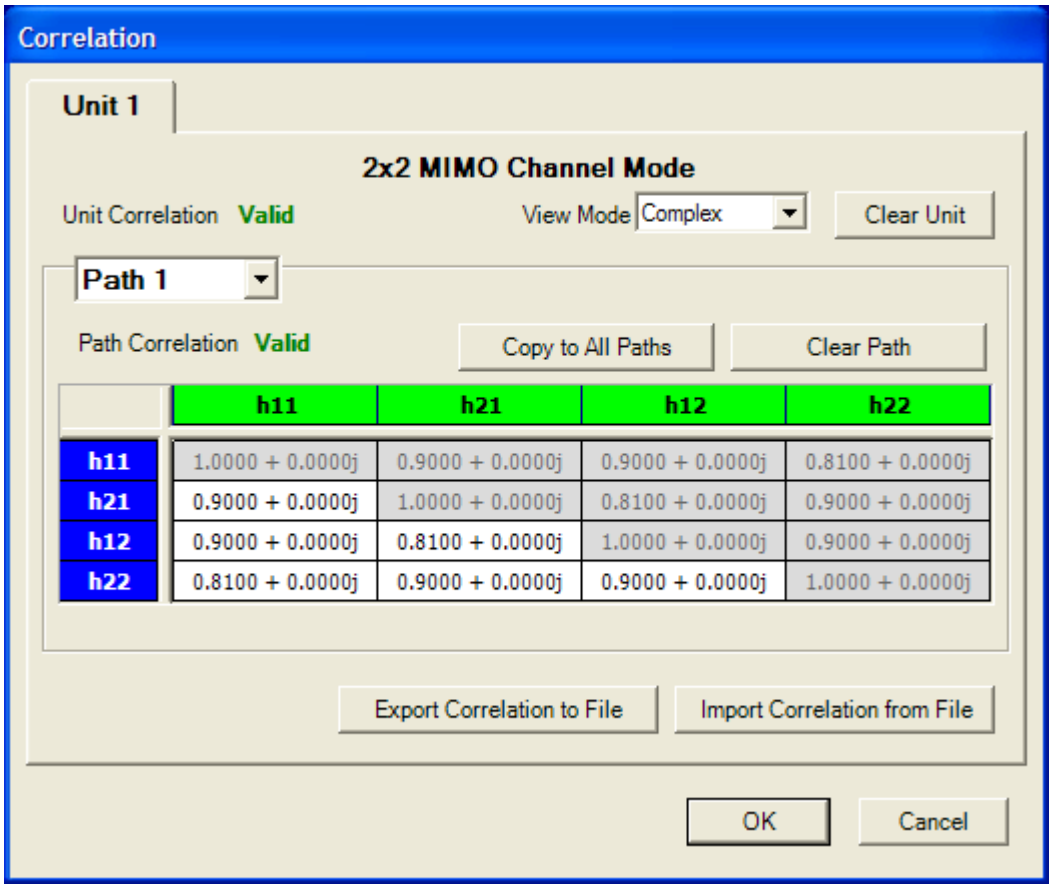


Figure 2-131: Dynamic Correlation Window

A unique correlation matrix can be specified per path, if desirable. Typically, the same correlation matrix is used for each path. Click the **Copy to All Paths** button to copy the current matrix to all paths.

Once the correlation has been specified, click **Export Correlation to File** to export the correlation to a .CORR file, as shown in Figure 2-132.

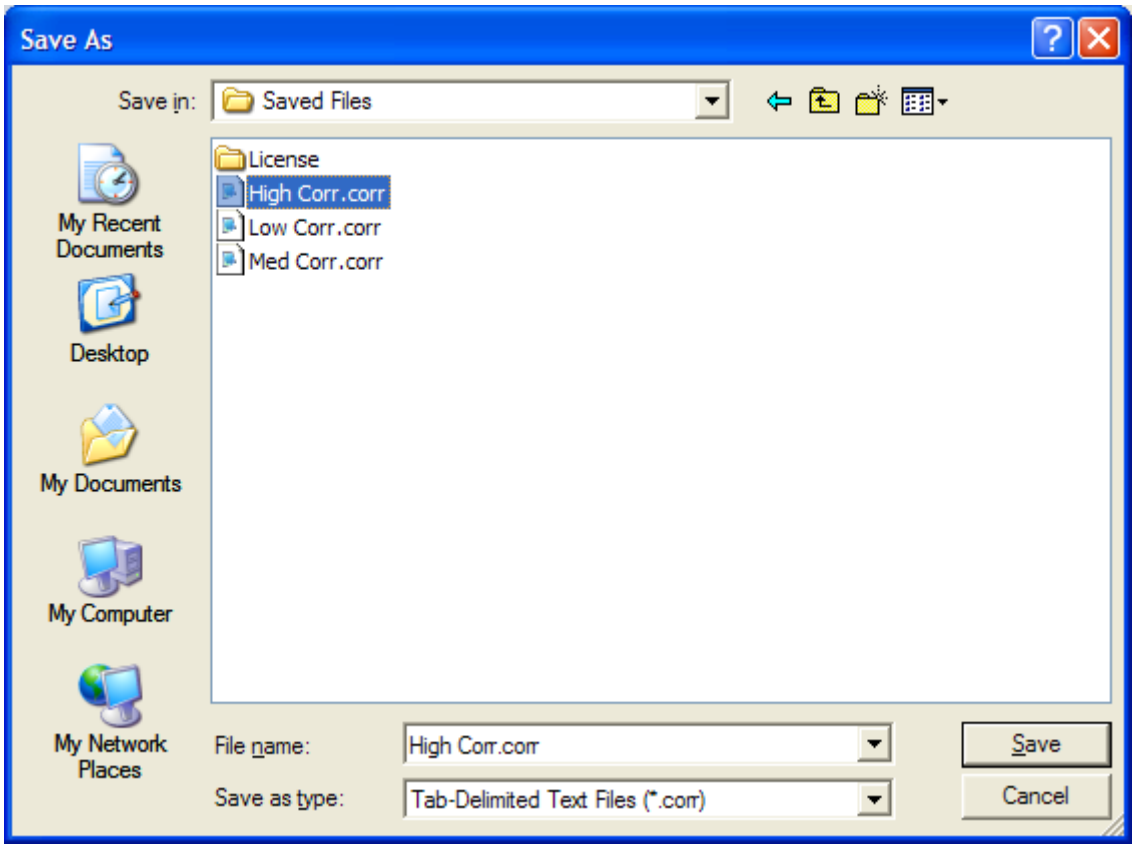


Figure 2-132: Exporting a Correlation (.CORR) file

Using this method, one can build up a library of correlation files for use in DEE.

2.8.5.2 Specifying Correlation Matrices in DEE

The correlation file to use for a given state is specified when the DEE state file created using the DEE Template. The column for specifying correlation files is located in the last column of the template. Clicking on any cell in this column will reveal a small browse button allowing one to browse to the correlation file. Figure 2-133 illustrates specifying correlation files in the DEE Template.

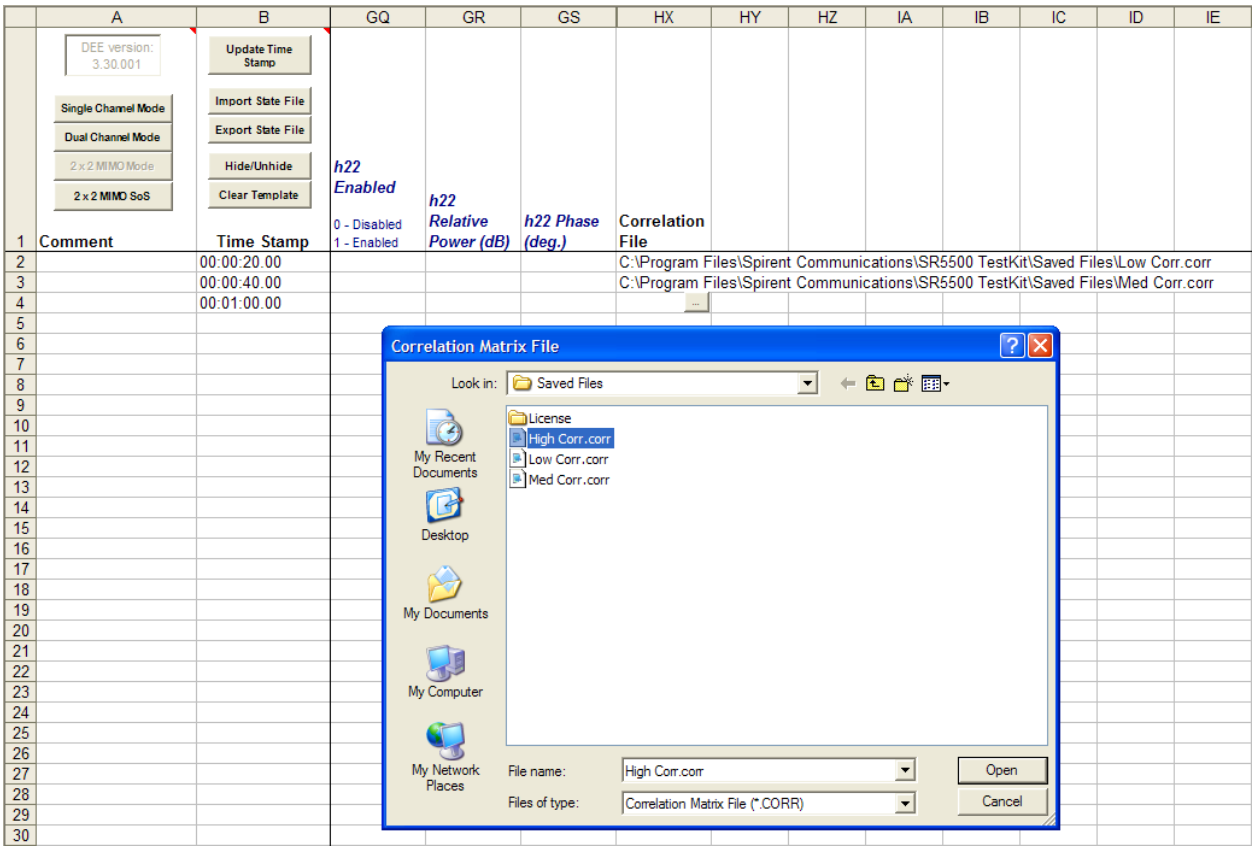


Figure 2-133: Specifying Correlation (.CORR) Files in DEE

The scenario shown in Figure 2-133 is a complete 3 state DEE scenario where the correlation varies from a low correlation environment to a high correlation environment over the span of 60 seconds.

Once complete, the scenario can be exported to an .STB file by clicking "Export State File" in the DEE Template.

2.8.5.3 Running DEE with Dynamically Changing Correlation

From the DEE View, simply select the .STB file and click the "Enable" button, as shown in Figure 2-134. When compilation is successful, DEE can be entered and run as described in the previous sections.

NOTE: When enabling DEE with Dynamic Correlation, there will be a period of time where TestKit downloads the correlation data to the SR5500. This may take up to approximately 60 seconds if the maximum number of 8 matrices are being used.

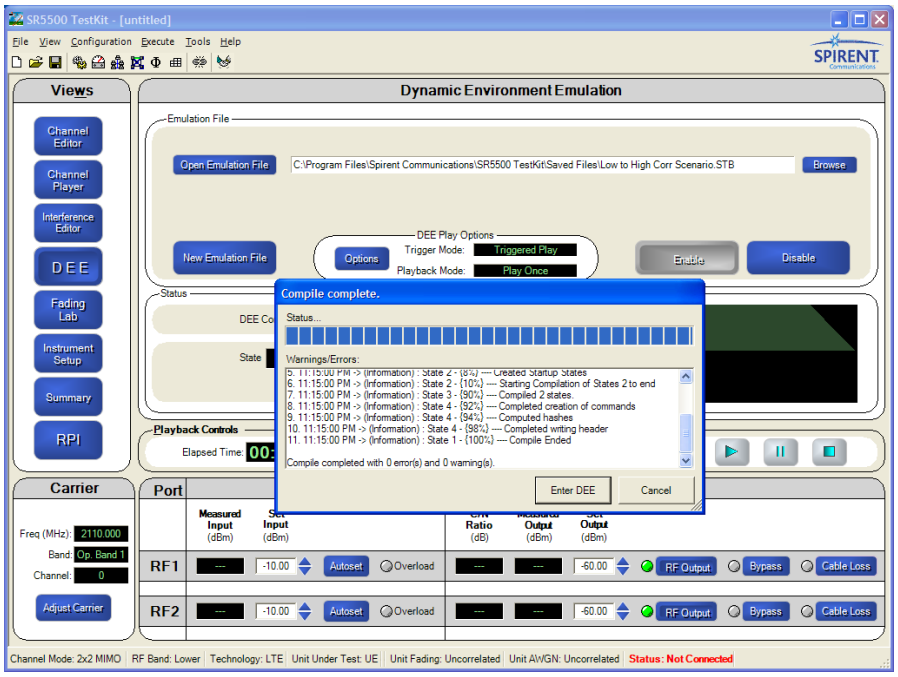


Figure 2-134: Running DEE with Time Varying Dynamic Correlation

NOTE: Specifying Correlation matrices is only available in MIMO 2X2 mode. A Complex 4X4 Correlation Matrix is expected at compile time, otherwise, a compiler error will be generated. Envelope and Component correlation matrices is not supported in DEE, however, these can be expressed as an equivalent Complex correlation matrix.

NOTE: Up to 8 unique Correlation matrix files can be specified per DEE template. An error will be generated at compile time if more than 8 matrices are specified.

2.8.5.4 Dynamically Time Varying Correlation in DEE with Multiple SR5500s

It is possible to run dynamically time varying correlation in DEE with multiple SR5500s in a number of different ways as described in the following table.

Multiple SR5500 Dynamic Correlation			
Number of SR5500s	Correlation Mode	Expected Matrix Size	Comments
1		4x4	
2	System-based	8x8	There are 8 channels in a two-SR5500 system, therefore, an 8x8 matrix is required to fully correlate the channels.

Multiple SR5500 Dynamic Correlation			
3	System-based	12x12	There are 12 channels in a three-SR5500 system, therefore, a 12x12 matrix is required to fully correlate the channels
4	System-based	16x16	There are 16 channels in a four-SR5500 system, therefore, a 16x16 matrix is required to fully correlate the channels.
2	Instrument-based	4x4	A different 4x4 matrix can be specified for each SR5500, up to 2 in effect per state, but the correlation between SR5500s is zero.
3	Instrument-based	4x4	A different 4x4 matrix can be specified for each SR5500, up to 3 in effect per state, but the correlation between SR5500s is zero.
4	Instrument-based	4x4	A different 4x4 matrix can be specified for each SR5500, up to 4 in effect per state, but the correlation between SR5500s is zero.

NOTE: In multi-SR5500 System-based cases, the correlation matrix specified in the primary SR5500's state file will take precedence. Any matrices specified in secondary SR5500s will be ignored..

NOTE: In multi-SR5500 Instrument-based cases, the correlation matrix specifies the correlation between channels within the given SR5500, but correlation between channels across SR5500s is zero.

2.8.6. Sum Of Sinusoids (SOS) DEE

DEE is capable of time varying Sum of Sinusoids scenarios including time varying SCM, SCME, and WINNER scenarios. To create Sum of Sinusoids scenarios in DEE, click the "MIMO 2X2 SoS" button in the DEE Template as shown in Figure 2-135.

	A	B	C	D	E	P	Q	R	S	T	U	V	W
	DEE version: 3.30.001	Update Time Stamp											
	Single Channel Mode	Import State File											
	Dual Channel Mode	Export State File											
	2 x 2 MIMO Mode	Hide/Unhide											
	2 x 2 MIMO SoS	Clear Template											
1	Comment	Time Stamp	State Duration (s)	RF1 Output Power (dBm)	RF2 Output Power (dBm)	MIMO P1 Status 0 - OFF 1 - ON	MIMO P1 Delay (us)	MIMO P1 Relative Path Loss (dB)	MIMO P1 AOA (deg.)	MIMO P1 AOD (deg.)	MIMO P1 AsMs (deg.)	MIMO P1 AsBs (deg.)	MIMO P1 Doppler Velocity (Km/h)
2		00:00:01.00	1.000			1	0.1000		0.0				
3			1.000			1	0.2000		15.0				
4			1.000			1	0.4000		30.0				
5			1.000			1	0.6000		45.0				
6			1.000			1	0.8000		60.0				
7			1.000			1	1.0000		75.0				
8			1.000			1	1.2000		90.0				
9			1.000			1	1.0000		105.0				
10			1.000			1	0.6000		120.0				
11			1.000			1	0.4000		135.0				
12			1.000			1	0.2000		150.0				
13			1.000			1	0.1000		165.0				
14													
15													

Figure 2-135: Creating Sum of Sinusoids State Files in DEE

In the scenario identified in Figure 2-108, MIMO Path 1 Angle of Arrival (AOA) varies by 15 deg. per second across 180 deg. and MIMO Path 1 Delay varies from 0.1 microseconds to 1.2 microseconds back to 0.1 microseconds. Total duration is 12 seconds.

Sum of Sinusoids State Files are exported, compiled, and selected in the DEE View as described in the preceding sections.

In Sum of Sinusoids DEE, the following parameters can be changed:

- Channel Output Power
- Path Status (ON/OFF)
- Path Delay
- Relative Path Loss
- Angle of Arrival
- Angle of Departure
- MS Angle Spread
- BS Angle Spread
- Doppler Velocity

3. For a full description of these parameters and Sum of Sinusoids mode, refer to Section 2.7.3: Sum of Sinusoids Mode.

NOTE: In Sum of Sinusoids DEE, the minimum state duration is 200 milliseconds.

2.8.6.1 Sum of Sinusoids DEE with Multiple SR5500s

It is possible to run dynamically time varying Sum of Sinusoids in DEE with multiple SR5500s. Up to four synchronized SR5500 units is supported.

To run SOS DEE simultaneously on up to four systems, create an STB file for each unit using the DEE template and select the files in the main DEE view.

The STB files for all of the units must have the same number of states. The State Duration is determined from the State Duration information in the STB file for Unit 1. State duration information provided in other STB files is ignored.

NOTE: Correlation is not supported in Sum of Sinusoids mode. Correlation is implicitly achieved through the antenna and model geometry.

NOTE: Sum of Sinusoids DEE is only available in 2X2 MIMO Channel Mode. Furthermore, the MIMO option and GCM option must be present in the SR5500.

2.9. Fading Lab

Fading lab allows you to play back data from real-world measurements and simulations (channel sounder, ray tracing software, custom design simulations, etc.). Fading Lab uses the Fading Data Playback engine to playback the data. Refer to the Spirent Fading Studio product line for details on supported SCM and SCME models. This section details the parameters that control the Fading Lab function available through the TestKit/SR5500 GUI.

NOTE: Due to the high data rate requirements of Fading Data Playback, it only functions if there is a direct Ethernet connection between the controller PC and the SR5500 through a hub or Ethernet switch. Fading Data Playback may not function properly over a public network using a router.

NOTE: The Fading Data Playback feature is not currently available when the channel mode is set to 4x4 MIMO. The Fading Data Playback feature is supported only for the SR5500M.

NOTE: Verify that the Ethernet cable connected to the AUX-E port of the SR5500 is plugged into a hub/switch and not left hanging loose.

If the Ethernet cable to the AUX-E port is disconnected in the middle of a File download, the unit has to be reset before attempting the download again.

The Fading Data Playback feature allows you to playback recorded/measured fading data on the SR5500 at a specified sample rate. The following parameters can be changed:

- I data
- Q data
- Delay

2.9.1. Method

To playback data, the unit needs to be in 2x2 MIMO mode. SR5500 TestKit automatically changes the channel configuration of the unit to 2x2 MIMO in case it is in another mode.

NOTE: While Fading Data Playback is enabled, only the Carrier Frequency, Input, Output Levels, Power Meter Parameters can be changed. Autoset and Player functionality is available.

1. Export the Fading Data (from a *.txt file or any of the supported formats) to the Fading Data Playback file (*.cpf or *.fdp).
2. Using the Fading Lab view in the main GUI:
   Refer to page to page 106 for more information on the Fading Lab view.
   a. Load the Fading Data (CPF) file.
   b. Enable Fading Data Playback.
   c. Play the Data file.

2.9.2. Fading Data Playback File Creation

The Fading Data file defines the changes to the state of the SR5500. The user can create the Fading Play back file directly or compile a text based file into a Fading Data Playback file using the Spirent Fading Data Playback Compiler.

2.9.2.1 Fading Data Playback File Format

The Fading Data Playback file (*.cpf) is a binary file that can be created by a user or generated by the Fading Data Playback compiler. The File has a header section followed by the data samples.

2.9.2.2 Fading Data Playback Text File Format

The Fading Data Playback file should a text (*.txt) data file generated as per the following instructions:

Each file will consist of two parts: a header section followed by a data samples section as show below.

[Header]

[Data]

All parameters should be tab delimited.

Comment lines should start with the following "//". The first 2 characters of a comment line *must* be "//" for the compiler to recognize this line as a comment line. Comments should exist on separate lines than the header or data samples otherwise the compilation of the file will fail.

Blank lines will be ignored during compilation.

The file should have the following header:

Version[tab]1.1.0[crlf]

H11_Paths[tab]xx[crlf]

H12_Paths[tab]xx[crlf]

H21_Paths[tab]xx[crlf]

H22_Paths[tab]xx[crlf]

Where xx represents the number of paths for a given radio link ranging from 0 to 24.

The file supports up to four 4 radio links: H11, H12, H21 and H22. This allows at most a MIMO 2x2 channel configuration. Each radio link can have 0-24 paths consisting of Delay, I and Q values.

The following is a sample of the data format:

DelayP1_H11 I_H11_P1 Q_H11_P1 DelayP1_H12 I_H12_P1 Q_H12_P1 DelayP1_H21 I_H21_P1 Q_H21_P1 DelayP1_H22 I_H22_P1 Q_H22_P1 DelayP2_H11 I_H11_P2 Q_H11_P2 ... DelayP24_H22 I_H22_P24 Q_H22_P24[crlf]

This gives a total 288 tab-delimited numerical values per line. Each line should end with [crlf]. Lines with anything other than 288 tab-delimited numerical values will result in a compilation error. When there are less than 24 paths for a radio link, set the unused path samples to zero.

Each line of data samples represents 0.2 ms of fading.

I and Q are voltage scalar values ranging from -1.0000 to 1.0000. The magnitudes of I & Q should be bounded by the following equation: $\sqrt{I^2 + Q^2} \leq 1$

Delay can be set to a value between 0.0 and 2000000.0 ns with a resolution of .1ns.

NOTE: The current version of Fading Data Playback uses the same delay for h11 and h12, and similarly for h21 and h22.

Units of Delay is ns Below is a sample *.txt file:

//Header Information File Version 1.1.0

Version 1.1.0

H11_Paths 12

H12_Paths 1

H21_Paths 24

H22_Paths 24

//Data samples begins here

//DelayP1_H11 I_H11_P1 Q_H11_P1 DelayP2_H12 I_H12_P2 Q_H12_P2 .....

25.0 9.3e-15 2.1e-15 133.3 6.1e-14 3.3e-14.....

I and Q decide the scaling factor which sets the power for a path. For distribution of power when you have multiple paths, refer to Section 2.7.2.15 (Power Distribution among Paths). The actual output power of the SR5500 depends on the I & Q values of the path and the relationship between the paths.

2.9.2.3 Fading Lab: Fading Data Compiler

The Fading Data Compiler converts the txt file into a proprietary binary file (*.cpf). The Fading Data Compiler can be found at **Start›All Programs›Spirent Communications›Fading Data Compiler** or at: **C:\Program Files\Spirent Communications\Fading Data Compiler**.

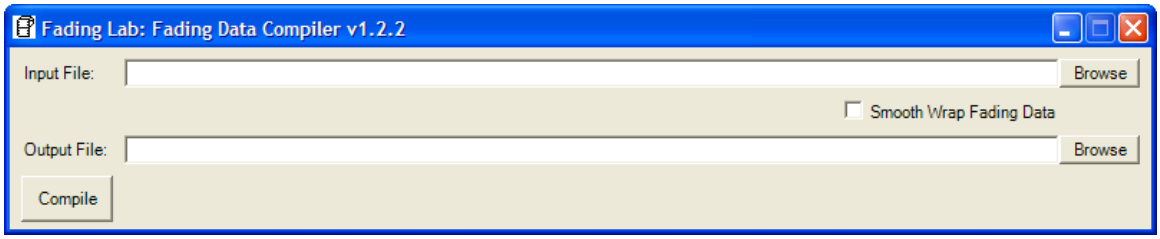


Figure 2-136: Fading Data Compiler

The Fading Data Compiler parses the data in the text file, performs an error check and scales the values appropriately into the .cpf file.

The compiler:

- Scales the I and Q values to ensure that $\sqrt{I^2 + Q^2} \leq 1$; this is done by normalizing all I/Q samples by the sample with the maximum magnitude.
- Dictates the maximum power that is allowable for each path on that radio link based on the number of paths in each radio link.
- Distributes the power of each radio link evenly across all the paths.

The actual power out of the box depends on the I/Q values and the phase relationship between the paths. For instance, if there are 24 paths in a Radio Link with an I value of unity, the instantaneous power would be $Set\ Output + 20\log(\sqrt{24})$ dBm. If the paths are out of phase (such as when they have different frequency shifts), the power out of the box would match the Set Output. If there was a single path (or multiple paths with different phase shifts) on the two radio links that sum at the output (h11& h12 or h21&h22), the output would be 3dB greater than the set output.

After selecting the "Smooth Wrap Fading Data" option, the Fading Data Compiler modifies input data to make the 'glitch' encountered when a discontinuity is encountered when wrapping from the last sample back to the first sample is minimized. During the process a maximum of last 5000 sample points may be modified.

NOTE: The current version of the Fading Data Compiler uses the delay specified for h11 for h11 and h21, and similarly the delay specified for h22 for h12 and h22.

2.9.3. Fading Lab View

The SR5500 is capable of playing back fading from a Fading Data Playback file.

2.9.3.1 Accessing the Fading Lab View

Access the Fading Lab view by clicking the Fading Data Playback button in the *View Shortcut* window, or by selecting **View›Fading Lab**.

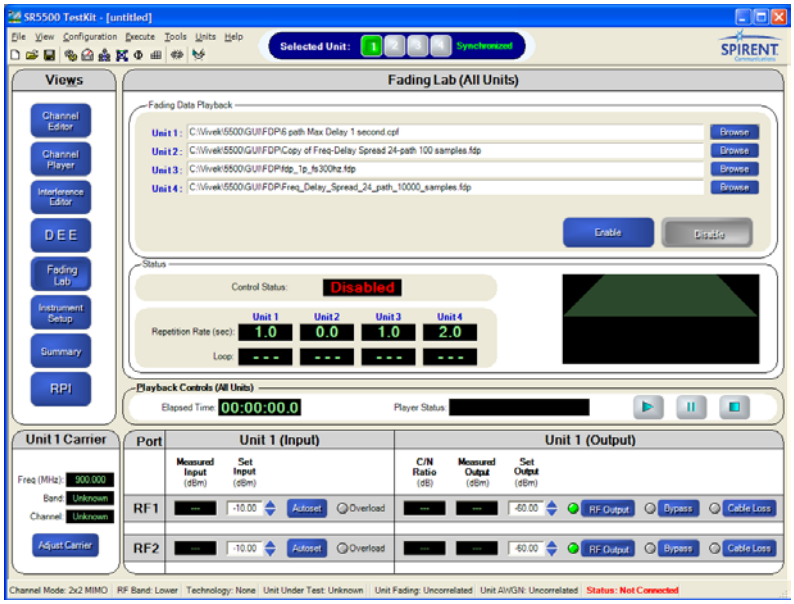


Figure 2-137: Fading Lab View

2.9.3.2 Selecting a Playback File

Select the Fading Data Playback file by clicking the Browse button. If you are controlling multiple SR5500s, you must select a separate file for each unit.

NOTE: When the SR5500 reaches the end of a file, it will continue playing until Stopped by looping through the file.

2.9.3.3 Enabling Fading Data Playback

Fading Data Playback can be enabled by clicking on the Enable button. When Fading Data Playback is enabled, the following sequence of events occur:

1. The Channel Editor, DEE Views, Test Assistant, File Save Recall, System/Communication Setup and the Correlation dialogs are made unavailable and can't be accessed without disabling Fading Data Playback first.
2. The software compiles the Emulation file into a machine-readable format. A window opens displaying the status of the DEE compile. If the compile is successful, click the Enter DEE button.

2.9.3.4 Disabling Fading Playback

Disable Fading Data Playback by clicking the Disable button. This stops the Fading Data Playback engine, restores the instrument to its original state before entering Fading Data Playback and re-enables access to all TestKit views.

2.9.3.5 Playing (Running) Fading Data Playback

After enabling Fading Data Playback, when the player is stopped, there is a single static path from the input to the output; the output powers is set to the power in State 1. When the player starts playing, the path parameters and the output levels vary based on the values for that state. Refer to Section 2.2.2.6 on page 29 for details on how to play, pause, and stop.

When you click the Play button , the fading engine begins, and the Fading Data Playback engine begins cycling through the states in the Playback file.

2.9.3.6 Fading Playback Status Information

The following Information is provided from the Fading Data Playback engine:

Repetition Rate – This indicates the duration after which the file will repeat itself.

Current Loop – This indicates how many times the states have been looped.

Elapsed Time – Indicates the total time that Fading Data Playback has been playing.

Player Status – Indicates the state of the Player – Playing/Stopped/Paused.

Fading Playback Animation – A simple animation providing a visual cue that Fading Data Playback is running. The state of the animation has no effect on the actual PDP of the current state.

Measured Input Level – Shows the constantly measured and displayed input level.

Calculated Output Level – The average output power is calculated and displayed based on the measured input level. The output level measurement assumes a valid path set-up. In an extreme example with all paths turned off, the output power displayed will be incorrect.

Set Output Level – Displays the set output level for the current state.

2.9.4. Using Fading Data Playback with Multiple SR5500s

TestKit is capable of playing fading data simultaneously on up to four SR5500 units. Refer to Section 2.14 on page 131 for more information on multi-unit control.

To run Fading Data Playback simultaneously on up to four systems, create an CPF file for each unit and select the files in the Fading Lab view.

2.10.Using the SR5500 with 6 GHz/6GHz-EX Option

The SR5500 6 GHz(-EX) RF Converter can increase the frequency range of the SR5500. The SR5500 6 GHz option supports the Upper Band (4100 to 6000 MHz). The SR5500 6 GHz-EX option supports both the Upper and Middle (3300 to 3850 MHz).

2.10.1. Configuring TestKit for the 6 GHz(-EX) Option

The SR5500 controls the SR5500 6 GHz(-EX) RF Converter. It automatically detects the presence of the Converter when properly connected. This information is sent to TestKit when it connects to the SR5500. TestKit automatically makes the appropriate adjustments after detecting the 6 GHz(-EX) RF Converter.

2.10.2. Selecting Lower/Middle/Upper Band

To access the additional frequency band available by the SR5500 6 GHz(-EX) RF Converter, select **Lower**, **Middle**, or **Upper Band** by selecting **Configuration›System** or by clicking the **System/Communication Setup** icon from the toolbar to open the *System/ Communication Setup* window. A sample *System/Communication Setup* window is shown in Figure 2-138.

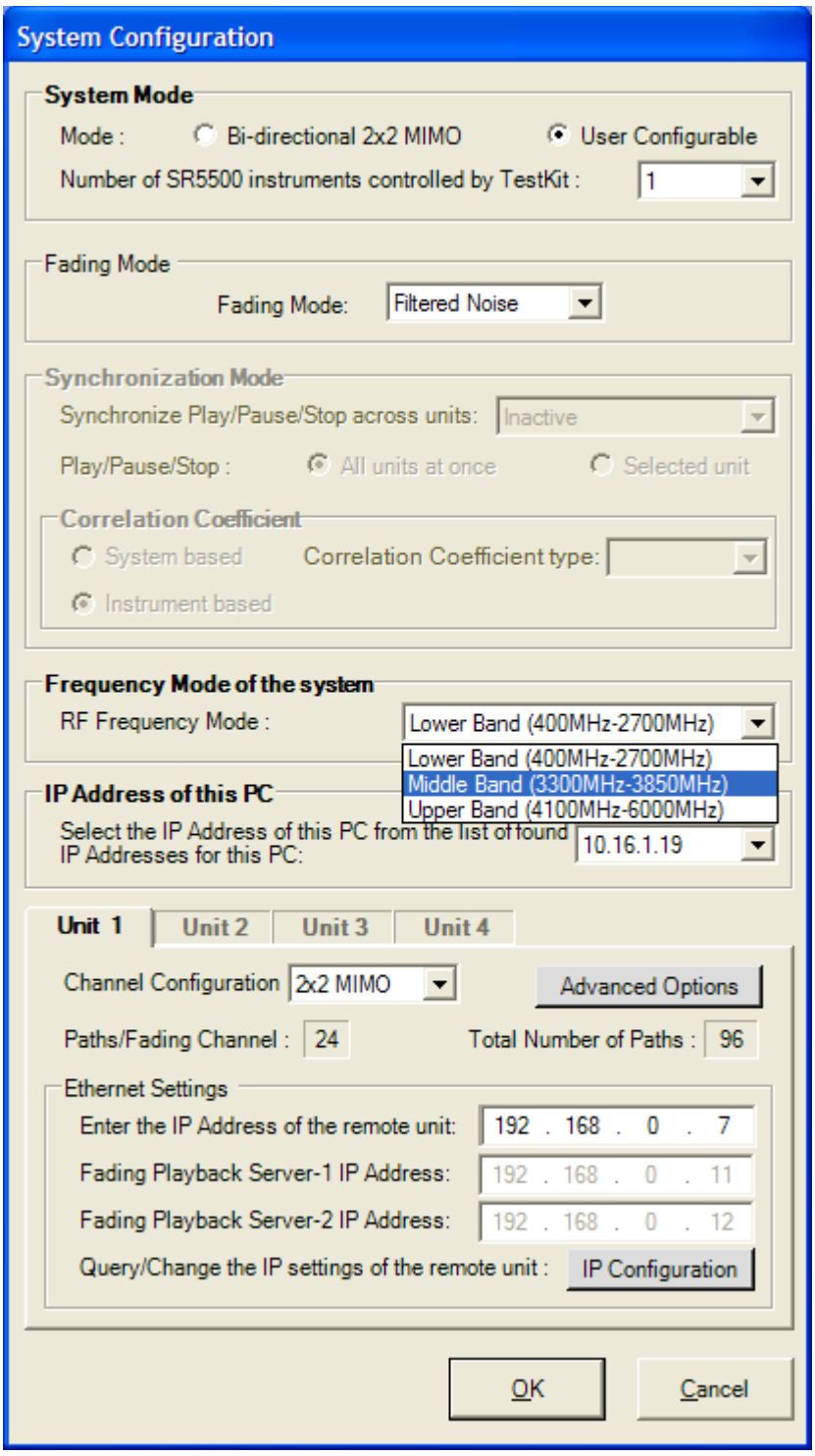


Figure 2-138: System Configuration Window – Selecting the Band

You can change the RF Frequency Mode from **Lower** to **Upper Band**, and vice versa. Refer to the Technical Specifications chapter on page 142 for details. Certain parameters reset when the RF Frequency Mode changes. Refer to Section 2.10.3. for details.

NOTE: The Middle Band is only available with the SR5500 6 GHz-EX option.

2.10.3. Parameter Dependencies

When the RF Frequency Mode is set to Upper Band, the SR5500 limits the range of the parameters listed below:

- Carrier Frequency
- Technology
- Unit Under Test
- Band
- Channel
- Output Level
- Input Level

NOTE: We recommend you make any necessary adjustments to the above parameter settings after changing the RF Frequency Mode parameter.

2.11. Downloading Firmware to the SR5500

NOTE: Having an Internet Firewall that prevents FTP access into the Host computer will cause the Firmware upgrade to fail. When SP2 of Windows XP is installed, a Firewall is automatically put in place. This firewall must be disabled before beginning the Firmware upgrade process.

The SR5500 comes with the required Firmware already installed. It may be necessary to download Firmware updates made available from Spirent Communications. This section details the steps to update the Firmware when necessary.

NOTE: The firmware upgrade procedure should only be performed when there is a direct Ethernet connection between the controller PC and the SR5500, either through a cross-over cable or using a hub. The firmware upgrade may not function properly over a network using a router.

2.11.1. Starting the Download

Successful installation of a new version of SR5500 TestKit automatically installs updated Firmware files in the download directory on the Controller PC. Once the files are properly located on the controller PC, run TestKit and connect to the SR5500. To start the download in SR5500 TestKit, select **Help›Firmware Upgrade**. TestKit must communicate with the SR5500 to detect the current Firmware version. The *Firmware Upgrade* window displays, as shown in Figure 2-139.

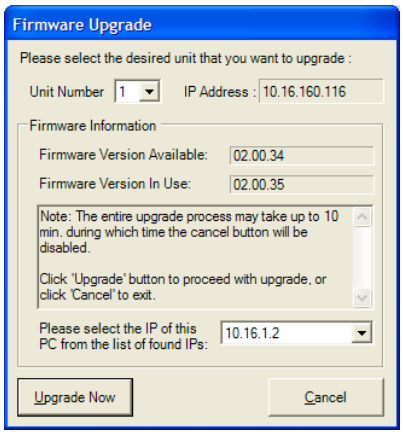

Firmware Upgrade
Please select the desired unit that you want to upgrade :
Unit Number
1
IP Address :
10.16.160.116
Firmware Information
Firmware Version Available:
02.00.34
Firmware Version In Use:
02.00.35
Note: The entire upgrade process may take up to 10 min. during which time the cancel button will be disabled.
Click 'Upgrade' button to proceed with upgrade, or click 'Cancel' to exit.
Please select the IP of this PC from the list of found IPs:
10.16.1.2
Upgrade Now
Cancel

Figure 2-139: Firmware Upgrade Window

Confirm the correct Firmware version to download. If connected to multiple units, select the unit to upgrade. You should also verify that the IP address displayed matches the port connected to the SR5500. Click the **Upgrade Now** button to start the Firmware download.

2.11.2. During the Download

During the Firmware download process, SR5500 TestKit instructs the SR5500 to retrieve certain files from the Controller PC via TCP over the Ethernet interface. Each file is a part of the Firmware in the SR5500 and is thoroughly checked to ensure proper transfer to the SR5500.

The SR5500 resets when the file transfers are complete, and TestKit reconnects to the unit.

2.11.3. Recovery in Case of Failure

Depending on the failure condition, it may be possible to recover by reattempting the firmware download procedure. If the reattempt fails, or is not possible, it is likely the unit requires service. Contact Spirent Communications customer care for more assistance.

2.12. Changing the Remote Connection

The connection between the controller PC and the SR5500 is a standard Ethernet connection. SR5500 TestKit and the SR5500 use standard TCP/IP to communicate over the Ethernet connection. Both the SR5500 and the controller PC are configured for proper communication. It is unlikely you will need to make any adjustment to this configuration.

In case you do need to change the Remote Connection configuration, use the instructions provided here to assist you. It is important that the SR5500 IP Address and the IP Address in TestKit match to ensure proper communication.

2.12.1. Changing the SR5500 IP Address Configuration

The address of the SR5500 Ethernet connection is a standard IP Address.

To modify the IP Address of the Ethernet connection:

1. Use the supplied RJ-45 Type connector to DB-9 Type connector serial cable.
   The serial cable connects the controller PC serial interface to the SR5500 serial interface labeled, "SERIAL".
2. Run SR5500 TestKit, but do not connect to the remote unit.
3. Select **Configuration›System/Communications Setup**,
   The *Communication Configuration* window displays.

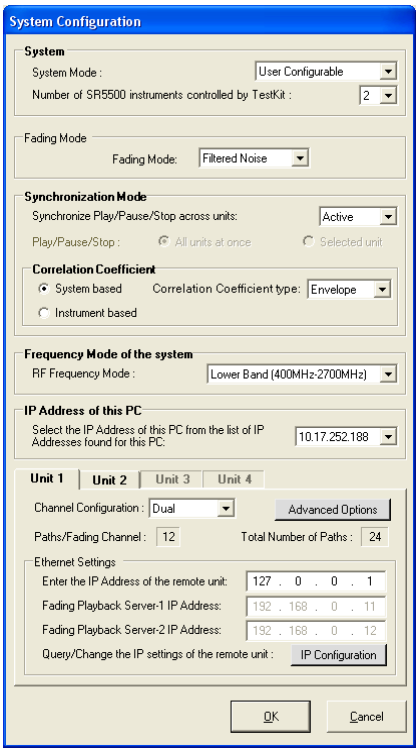


Figure 2-140: System Configuration Window – Changing IP Address

4. Click the **IP Configuration** button.
   SR5500 TestKit uses the COM port to communicate with the SR5500 and retrieve the current IP Address information.
5. If TestKit is controlling multiple SR5500s, connect the serial cable to each of them in series.
   The IP configuration is only for the system currently connected to the serial cable. If TestKit cannot communicate with the SR5500, it will display the appropriate error.
6. After collecting the IP Address information from the SR5500, SR5500 TestKit displays the current IP Address information. Adjust the IP Address information to the desired value.

7. Click **OK**.
   Your changes are updated in the SR5500 unit. After SR5500 TestKit has updated the IP Address in the unit, it automatically updates the IP Address it uses to communicate with the SR5500.
   It is not necessary to change the IP Address in SR5500 TestKit to match the updated SR5500 IP Address.

2.12.2. Changing the IP Address in SR5500 TestKit

You need to know the IP address of the unit before changing the IP Address to match the IP Address of the SR5500. SR5500 TestKit must be in Local Mode to adjust the IP Address parameter.

To change the IP Address SR5500 TestKit:

1. Select **Configuration›Communication**.
   The *Communication Configuration* window displays, as shown in Figure 2-141.
2. Edit the **IP Address** listed in the Ethernet Settings.
3. Click **OK** to save the changes and close the window. Click **Cancel** to abandon the changes and close the window.

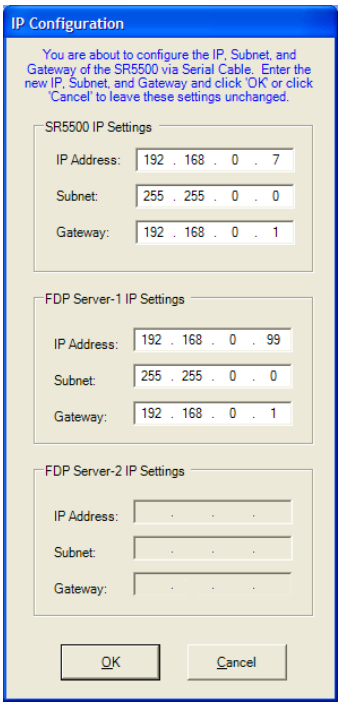

IP Configuration
You are about to configure the IP, Subnet, and Gateway of the SR5500 via Serial Cable. Enter the new IP, Subnet, and Gateway and click 'OK' or click 'Cancel' to leave these settings unchanged.
SR5500 IP Settings
IP Address: 192 . 168 . 0 . 7
Subnet: 255 . 255 . 0 . 0
Gateway: 192 . 168 . 0 . 1
FDP Server-1 IP Settings
IP Address: 192 . 168 . 0 . 99
Subnet: 255 . 255 . 0 . 0
Gateway: 192 . 168 . 0 . 1
FDP Server-2 IP Settings
IP Address:
Subnet:
Gateway:
OK
Cancel

Figure 2-141: Instrument Options Window

2.13.Updating the SR5500 Options

The SR5500 permits the field addition of software options via an encoded password file. Upon purchase of a soft option, a password file is provided which enables the purchased feature.

To enable the purchased feature, follow the instructions included with the password package provided by Spirent. Note that these instructions require you to perform the operation with TestKit connected to the SR5500.

To verify the SR5500 options and ASA expiration date, view the Hardware Options by selecting **Help>Hardware Information**.

Figure 2-142: Instrument Options Window

NOTE: SR5500 instruments purchased before version 1.20 may not have an ASA Expiration date embedded in them. If this is the case, contact Customer Service.

2.14.Controlling Multiple SR5500 Units

The TestKit GUI can control up to four SR5500 units simultaneously with synchronization that allows all fading paths to remain uncorrelated. To take advantage of this option, connect the SR5500s using the provided digital synchronization cables. Additionally, you must lock all 10 MHz references using BNC cables.

2.14.1. Connecting Synchronization Cables

Before using TestKit to control multiple SR5500 units, connect them with synchronization cables. These cables ensure that fading between channels in different systems remains uncorrelated, and when using DEE or Fading Lab, that the units change states at the same time.

The following table shows the required connections.

UNIT #	PORT		UNIT #	PORT	TYPE
1	10 MHz OUT	->	2	10 MHz IN	BNC
2	10 MHz OUT	->	3	10 MHz IN	BNC
3	10 MHz OUT	->	4	10 MHz IN	BNC
1	SYNC OUT	->	2	SYNC IN	MDR Digital Cable
2	SYNC OUT	->	3	SYNC IN	MDR Digital Cable
3	SYNC OUT	->	4	SYNC IN	MDR Digital Cable

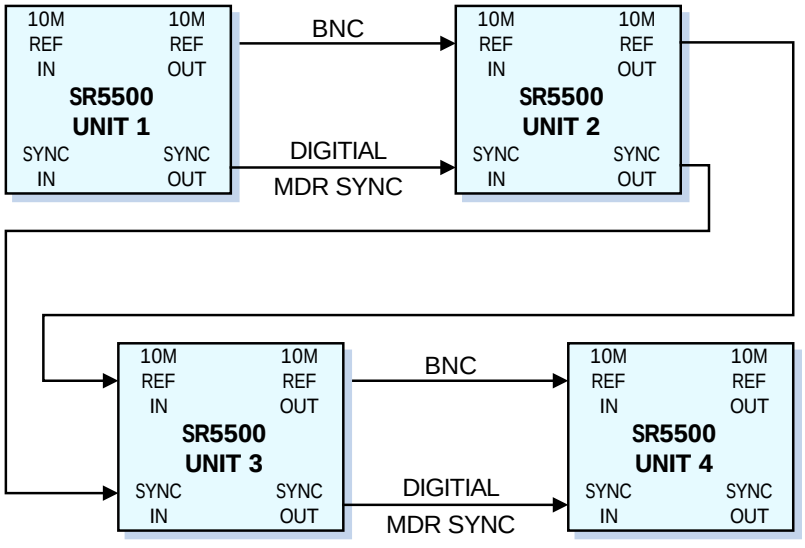


Figure 2-143: SR5500 Multi Unit Synchronization

When controlling less than four units, omit the cables to the systems not being controlled. The 10 MHz IN port of system 1 can be driven from an external source if desired.

2.14.2. Unidirectional 4x4 MIMO

Before using TestKit to control a 4x4 MIMO setup, connect the units with the synchronization and data bus cables. The synchronization cable allows correlation for the 4x4 system, and the data cables allow the input from one unit to be fed to the other unit.

The table below provides the required connections.

UNIT #	PORT		UNIT #	PORT	TYPE
1	10 MHz OUT	->	2	10 MHz IN	BNC
1	SYNC OUT	->	2	SYNC IN	MDR Digital Cable
1	DBB OUT	->	2	DBB IN1	MDR Digital Cable
2	DBB OUT	->	1	DBB IN1	MDR Digital Cable

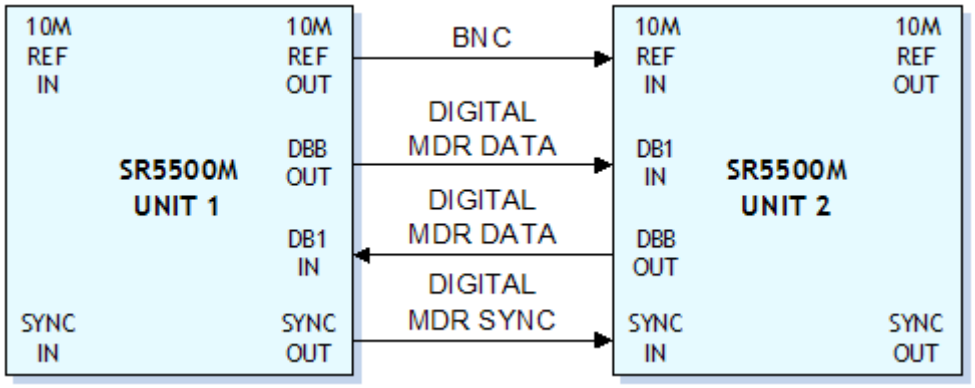


Figure 2-144: Unidirectional 4x4 MIMO Setup

Connect the Sync cables to the **SYNC IN/OUT** ports on the top of the rear panel of the unit.

When a 4x4 MIMO unit is being controlled with other units, connect the units as described in Section 2.14.1.

2.14.3. Fading Data Playback Setup

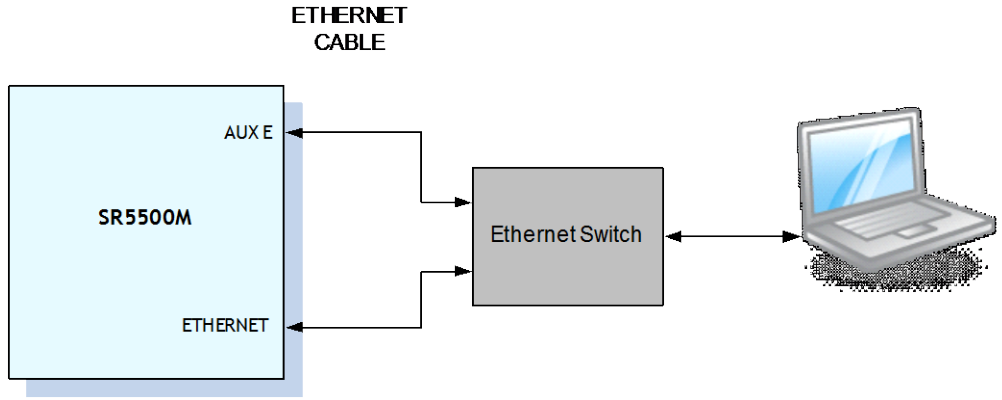


Figure 2-145: Fading Data Playback Setup- Single Unit

Before using TestKit for Fading Lab on multiple units, connect the four units with the synchronization cable.

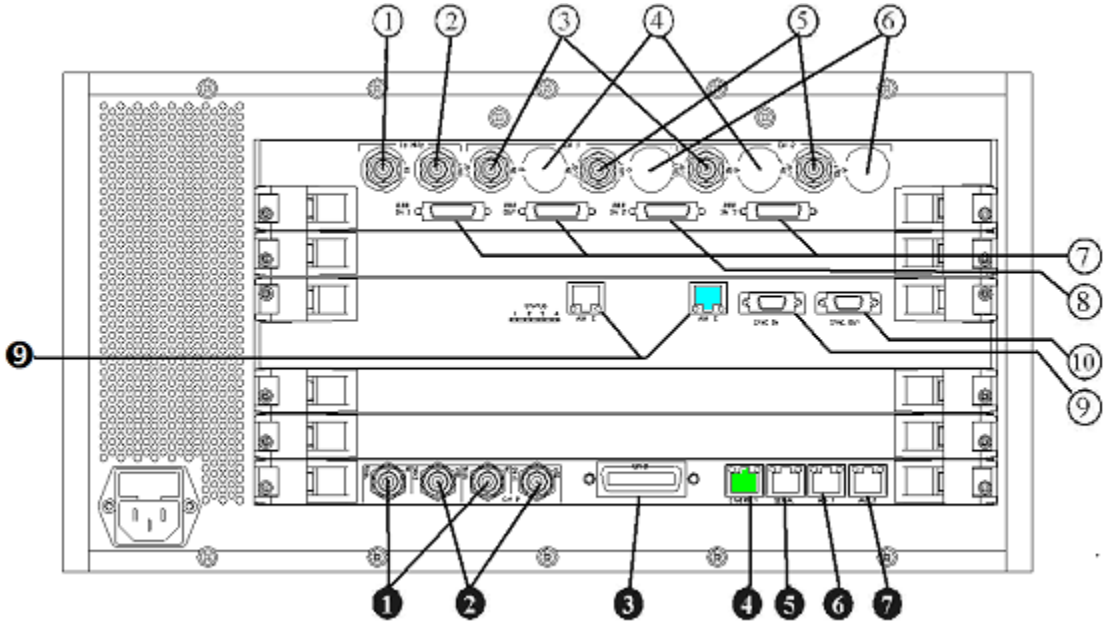


Figure 2-146: SR5500 Rear Panel

Figure 2-147 shows which ports need to be connected for Fading Data Playback.

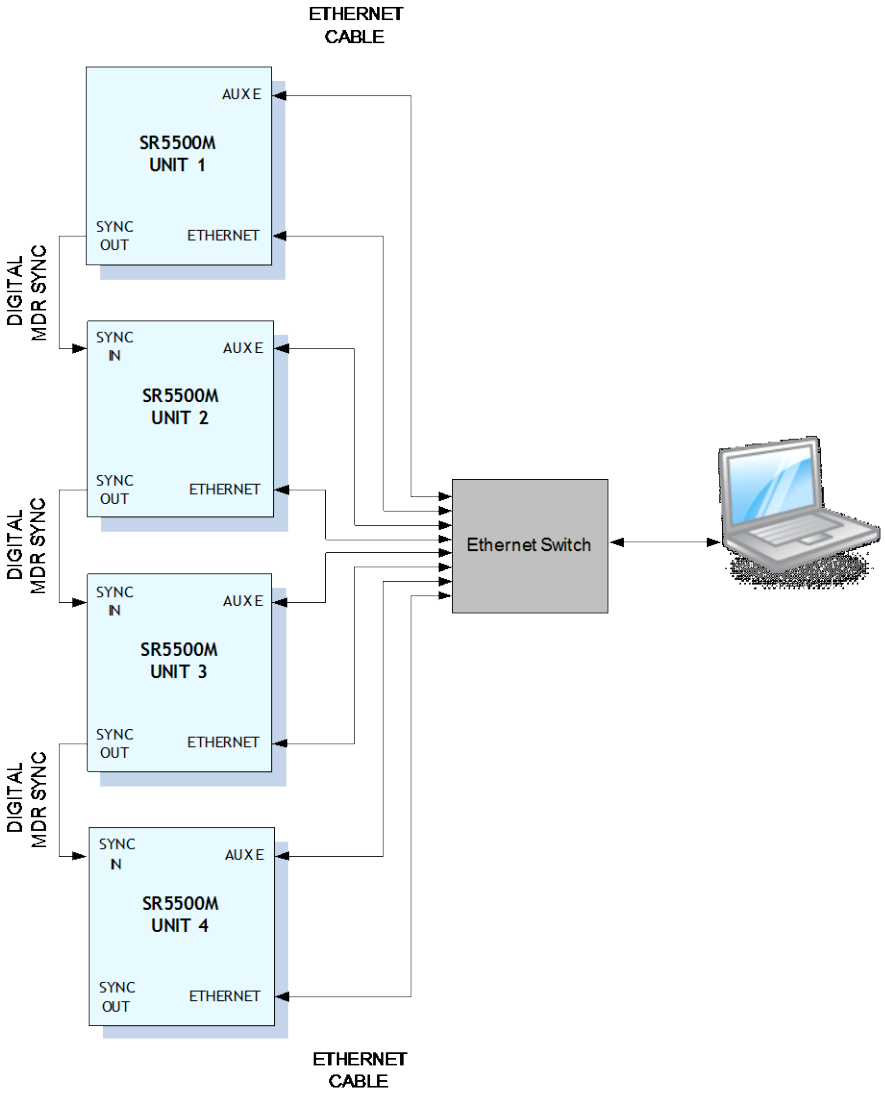


Figure 2-147: Fading Data Playback Setup- Multi Unit

2.14.4. Configuring TestKit to Control Multiple Units

Select the number of SR5500 units to control in the *System Configuration* window. To access this window, select **Configuration›System/Communication Setup**, or click the **System/Communication Setup** icon from the toolbar

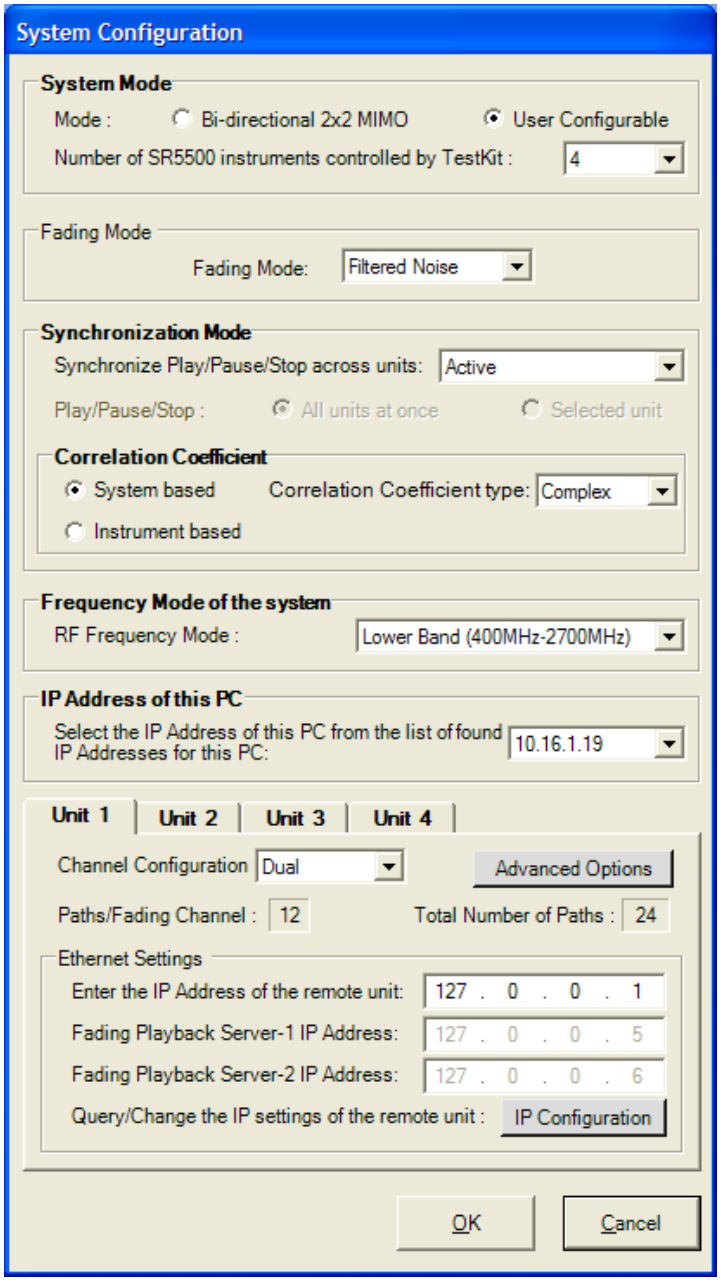


Figure 2-148: System Configuration Window – Controlling Multiple Units

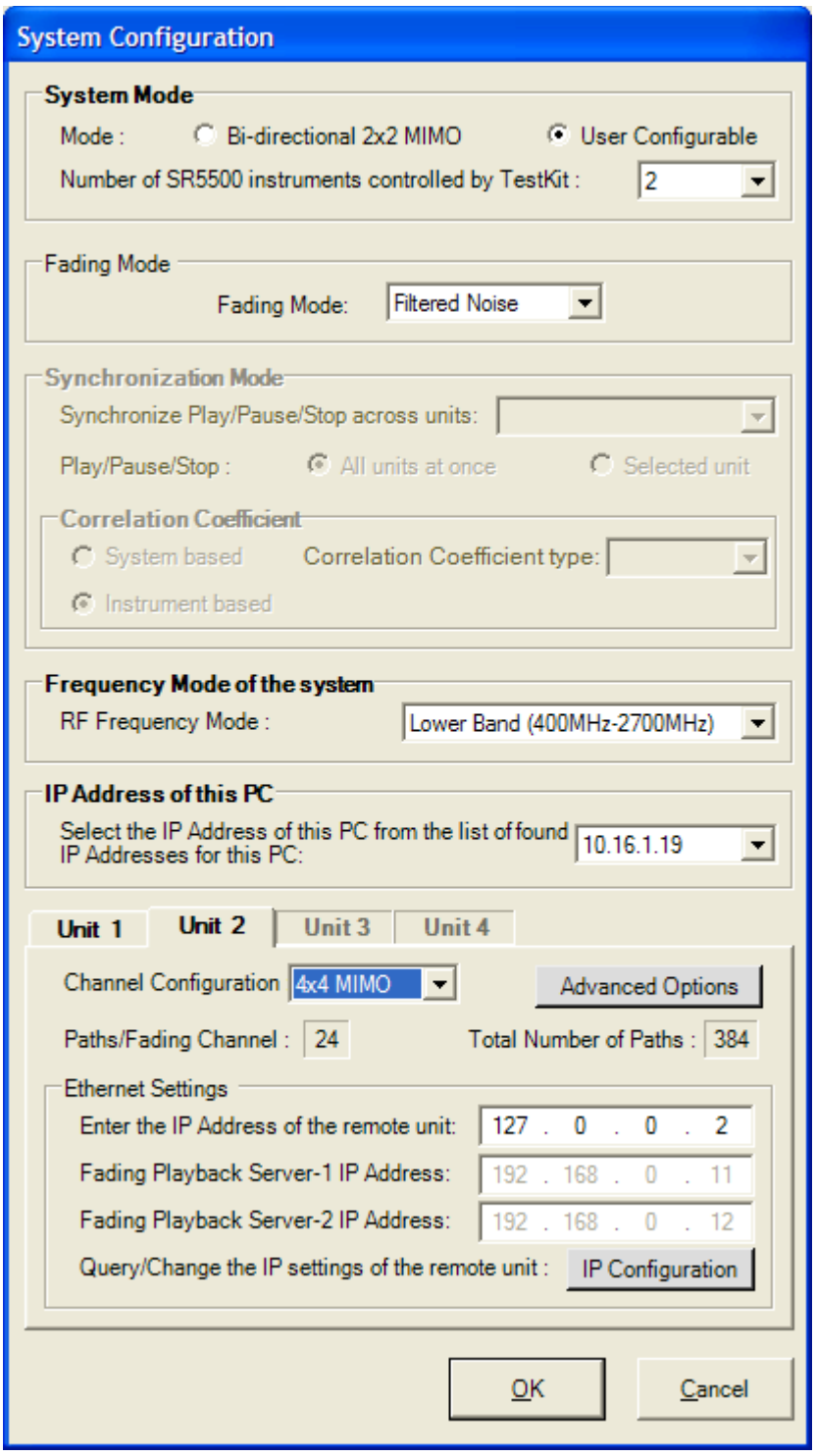


Figure 2-149: System Configuration Window – Setting 4x4 MIMO

The Channel Configuration, Crest Factor, and IP address can be set independently for each unit. Each unit must have a unique IP address.

The player Synchronization Mode can be set to **Active** or **Inactive**. For DEE and correlation to function in a multi-unit setup, you must set the Synchronization Mode to **Active**. The synchronization status is displayed with the unit selection.

Figure 2-150: Synchronization Status Bar

The Correlation Coefficient can be set to **Instrument-based** or **System-based**. Instrument-based correlation allows you to set the Rayleigh correlation between the two channels within a particular unit. System-based correlation allows the correlation to be set between channels in different units.

2.14.5. Switching between Units

When TestKit is controlling multiple units, the unit selection tool displays, as shown in Figure 2-151.

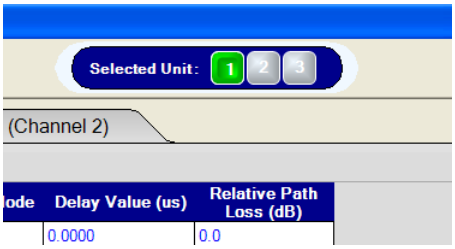


Figure 2-151: Unit Selection Tool

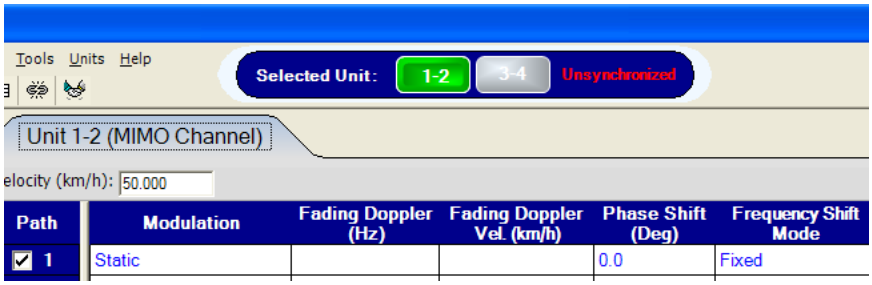


Figure 2-152: Unit Selection Tool - 4x4 MIMO Mode

To modify or view parameters for a particular unit, click the appropriate unit number in this toolbar. All of the information in the different views applies to the selected unit.

2.14.6. Player Functionality

When TestKit is controlling multiple units, you can set the player to control all units simultaneously, or independently. If the Synchronization Mode is set to **Active**, pausing or stopping causes all units pause or stop. This functionality allows you to set Rayleigh fading correlation between channels in different systems. If the Synchronization Mode is set to **Inactive**, changes to parameters in one unit do not impact other units.

2.14.7. Correlation Coefficient Type

The Correlation Coefficient Type can be set to Envelope, Component, or Complex. Complex can be set only if the Complex Correlation Option is present in every SR5500 in the Multi-unit System. Complex Correlation is the only option available in MIMO mode (2x2 and 4x4).

When the Correlation Coefficient Type is set to Envelope, the correlation is between the magnitude of the Rayleigh fading variables.

$$\text{Envelope Correlation (X, Y)} = \frac{E[|X||Y|] - E[|X|]E[|Y|]}{\sqrt{(E[|X|^2] - (E[|X|])^2)(E[|Y|^2] - (E[|Y|])^2)}}$$

Where:

X and Y are the complex fading variables applied to each path.

E[n] is the expected value of n.

When the Correlation Coefficient Type is Component, the correlation is set for the In-phase (I)(Real) components of each of the Rayleigh fading variables. Additionally, the same correlation is applied to the Quadrature (Q)(Imaginary) components of each the Rayleigh faded variables.

$$\text{Component Correlation } (\Re(X), \Re(Y)) = \frac{E[\Re(X)\Re(Y)] - E[\Re(X)]E[\Re(Y)]}{\sqrt{(E[\Re(X)^2] - (E[\Re(X)])^2)(E[\Re(Y)^2] - (E[\Re(Y)])^2)}}$$

$$\text{Component Correlation } (\Im(X), \Im(Y)) = \frac{E[\Im(X)\Im(Y)] - E[\Im(X)]E[\Im(Y)]}{\sqrt{(E[\Im(X)^2] - (E[\Im(X)])^2)(E[\Im(Y)^2] - (E[\Im(Y)])^2)}}$$

Where:

X and Y are the complex fading variables applied to each path.

E[n] is the expected value of n.

$\Re(n) = \text{Real component of n.}$

$\Im(n) = \text{Imaginary component of n.}$

When the Correlation Coefficient Type is Complex, the correlation between the Rayleigh fading variables is a complex number, and is defined as:

Where:

X and Y are the complex fading variables applied to each path.

E[n] is the expected value of n.

NOTE: Complex Correlation can be used to create correlation values previously achieved using component or envelope correlation settings.

To create a component correlation of x:

Complex correlation = x + 0i

To create an envelope correlation of x:

Complex correlation = $\sqrt{x}$ + 0i

2.14.8. System-Based Correlation

The correlation of Rayleigh fading between units can be set by selecting **Configuration›Correlation Coefficient Between Units** or clicking the **Correlation Coefficient between Units** icon in the toolbar.

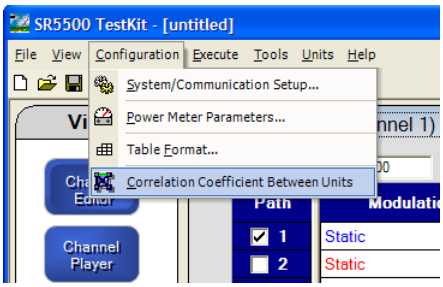
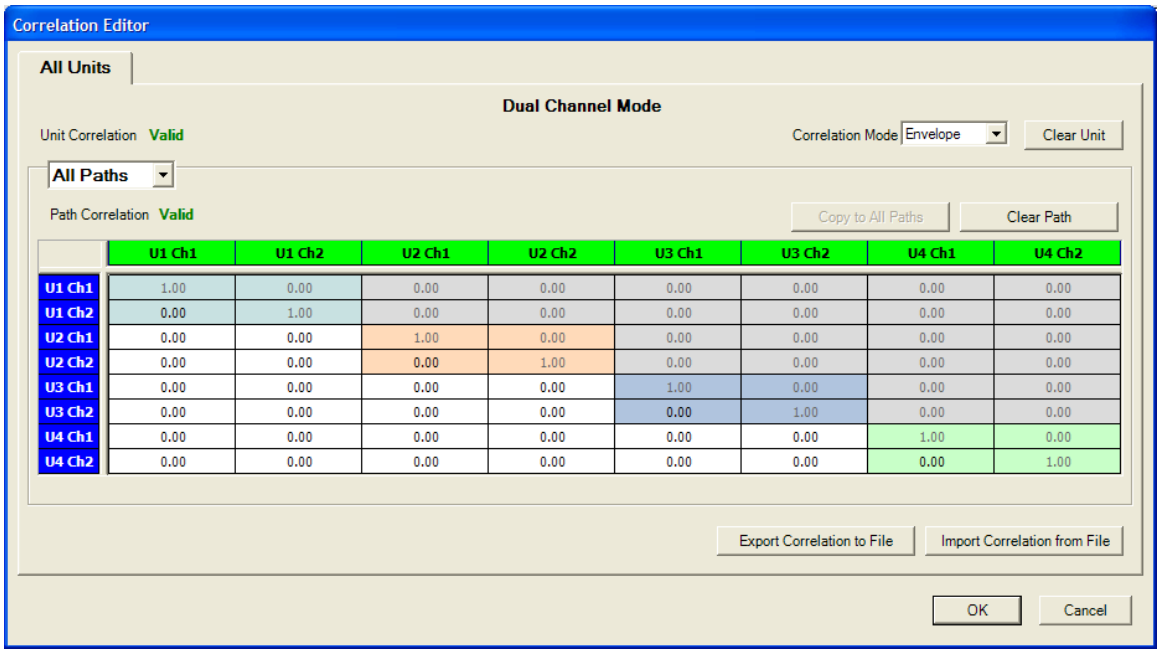


Figure 2-153: TestKit Configuration Menu

If the Correlation Coefficient type is set to Envelope or Component, the *Correlation Coefficients* window displays, as shown in Figure 2-154. In this window, you can set the Channel to Channel Correlation.



	U1 Ch1	U1 Ch2	U2 Ch1	U2 Ch2	U3 Ch1	U3 Ch2	U4 Ch1	U4 Ch2
U1 Ch1	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
U1 Ch2	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
U2 Ch1	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
U2 Ch2	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
U3 Ch1	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
U3 Ch2	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
U4 Ch1	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
U4 Ch2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00

Figure 2-154: Correlation Editor Window

Initially, this window shows all channels as *Uncorrelated*. You can enter values in any order. Values entered higher in the matrix affect the range of values lower in the matrix. Because of range dependencies, we advise you to enter the values from top to bottom by tabbing through the matrix.

NOTE: There are times when no range is possible for a given correlation coefficient. This occurs when the matrix cannot be physically implemented in the real world. If this occurs, the values elsewhere in the matrix must be changed to correct the condition.

The complete channel-to-channel correlation matrix displays in the Correlation Editor window. The matrix can be specified for each path for up to 12 paths (in a 2-channel setup) or 24 paths (in a single-channel setup) by selecting the appropriate path from the drop-down box at the top of the window.

Enter the values in the lower-left triangle of the matrix. The upper-right triangle displays the conjugate of the lower-left reflected about the main diagonal, enforcing the matrix to be Hermitian.

As you enter values, the matrix is tested for positive definiteness and the Path Matrix Status updates. If the test for positive definiteness fails, the Path Matrix Status displays “Invalid” in red, if it passes, it displays “Valid” in green. Each complex value is tested to make sure the magnitude is less than or equal to one. An error box displays if the magnitude of any complex value entered is greater than one (1).

You can enter a different complex matrix for each path. To set all paths to the same value, click the Copy **To All Paths** button. The displayed matrix then applies to all paths in the system.

To reset all matrices to zero, click the **Clear** Unit button.

After entering all value, click the **OK** button to implement the matrix or click the **Cancel** button to discard any changes.

The Set Reciprocal Correlation option allows you to correlate 2 System Synchronized 2x2 MIMO units. When this is selected, both units are Correlated as mirror images of each other.

After entering all values, click the **OK** button to implement the matrix or click the **Cancel** button to discard any changes.

Use the **Export Unit to File** button to export the correlation values to a tab-delimited text file that can be modified and imported using the **Import** Unit from File button. MIMO 2x2 or MIMO 4x4 units can be exported to and imported from legacy .TXT format files. All channel configurations can be exported to and imported from .CORR format files, which can be used in DEE mode.

3. Technical Reference

3.1. Overview

Wireless communication is a demanding application that requires complex air interface protocols to seamlessly interact and harsh radio channel effects to be mitigated. When a wireless signal is sent from the transmitter to the receiver it traverses a complex radio channel that distorts the intended signal transmission. The transmitted signal takes multiple paths to the receiver. These paths are caused by the signal bouncing off reflective surfaces such as the ground, buildings, or trees. Mobility between the transmitter and receiver causes the characteristics of these paths to be time-varying.

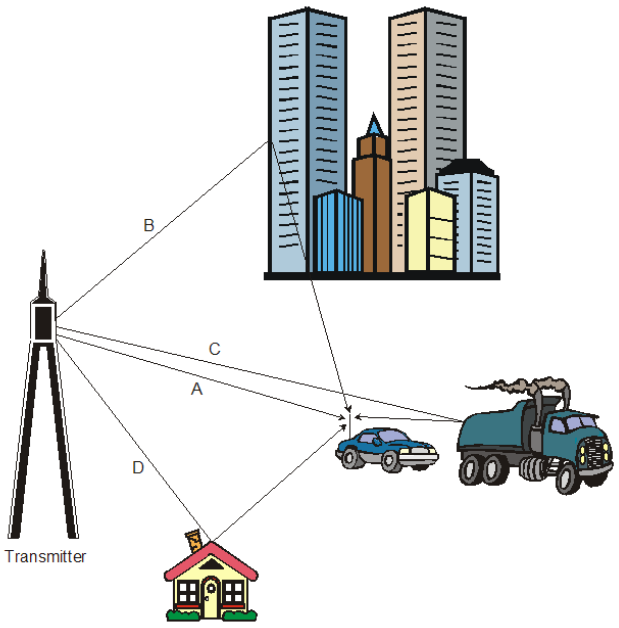


Figure 3-1: Typical Multi-path Fading Scenario

The radio propagation effects can be characterized by fast fading (also known as multi-path fading), relative path delay, relative path loss, and slow shadow fading (also known as log-normal fading). Different mobile environments generate various combinations of these effects. The cause of each of these characteristics will be discussed along with their effect on the transmitted signal. All of these characteristics can be demonstrated with a simple transmitter to receiver diagram. Figure 3-1 is a diagram of a typical mobile receiver (the car) as it drives along a roadway. Paths A, B, C, and D depict just four of the many signal paths from the transmitter to receiver.

Multiple versions of the originally transmitted signal display on the receiver; each having taken a different route (A-D) through the radio propagation channel, as shown in Figure 3-1. Because the macroscopic signal paths take a different route through the topology of the environment, they each travel a different distance from transmitter to receiver. This difference causes the paths to arrive at the receiver staggered in time and at a different average power level.

Fast and slow fading describe the time variation of the received signal level around an average power level. Fast fading describes the signal variations of a macroscopic path that take place over the course of several milliseconds. This level variation is primarily caused when the propagation channel creates destructive addition of the phases of a large number of reflected copies of the macroscopic path. These multiple received transmissions are generated by microscopic scattering of the macroscopic path from obstacles in the local geographical area (within a few hundred wavelengths of the receiver).

While fast fading effects are attributed to local scattering of the transmitted signal, topographical changes in the propagation channel introduce slow fading effects that vary over tens (10s) or hundreds (100s) of milliseconds. These signal variations are caused by a particular element of the geography, such as a mountain or large building, getting in between the transmitter and receiver; partially blocking signal reception. Slow fading is often described as shadow fading, since in effect, the geographic element casts a shadow on the receiver. Amplitude variation fluctuations happen at a slow rate.

3.2. Radio Channel Power Delay Profile

In wireless communications, a signal transmitted to a receiver can arrive having traveled over many different paths through the radio channel. On its way to the receiver, a transmitted signal may take the direct line of sight path or may bounce off reflecting surfaces before arriving at the receive antenna. Since these multiple copies of the original transmitted signal travel different distances, they arrive at the receiver staggered in time with different average power levels.

The impulse response of the radio channels is used to characterize what predominant paths are present between the transmitter and receiver at a given time. Using the impulse response method, a short transmit signal is broadcast through the radio channel and multiple copies of the original signal are captured and measured at the receive antenna. The result is displayed in the form of a Power-Delay Profile.

An example Power Delay Profile is shown in Figure 3-2. This example shows four copies of the original transmitted signal arriving at the receiver. The Y-axis describes the relative power of each of these paths at the receive antenna. The X-axis describes the relative time difference between the paths as they arrived at the receiver. Since the radio channel is dynamic, the amplitude and relative delay characteristics of the paths in the Power Delay Profile vary over time. The following sections describe various characteristics of the paths illustrated by the radio channel's Power Delay Profile.

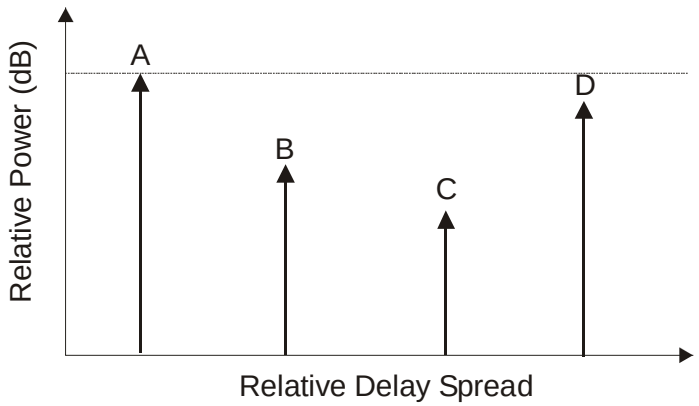


Figure 3-2: 2D – Power Delay Profile of Figure 3-1

3.3. Static Relative Path Delay

Relative path delay is a phenomenon where individual signal paths from the transmitter to the receiver arrive at different times. An example of this is shown in Figure 3-1 between Paths (A) and (C). Path (C) arrives at the receiver (the automobile) a finite time after signal Path (A). The net effect of the arrival time difference is to spread the originally transmitted signal at the receiver in time. In a digital wireless communications this causes received symbols to overlap; resulting in inter-symbol interference.

The amount of relative path delay varies with terrain and application. In an indoor application, delays could be in the tens (10s) of nanoseconds (ns), where 10 ns is about 10 feet. In outdoor applications, delays of 10 microseconds (μs) or less are typical (1 μs is about 1000 feet). Delays greater than 50 μs are rare in cellular environments.

Path delay in the SR5500 is set relative to the first arriving path. This delay setting is in addition to the absolute electrical delay through the system.

3.4. Time-Varying Relative Path Delay

A Power-Delay Profile, shown in Figure 3-3 provides a snapshot of the impulse response of a radio propagation channel. In mobile applications, the number of paths in a Power Delay Profile and their location along the delay spread X-axis would remain constant over several meters. In many cases the impulse response of a radio channel is averaged over this small distance (which translates into a short-period of time with mobility) to provide a “static” or wide sense stationary view of channel conditions. As a mobile wireless terminal moves over a wider area the shape and characteristics of the Power Delay Profile change dramatically.

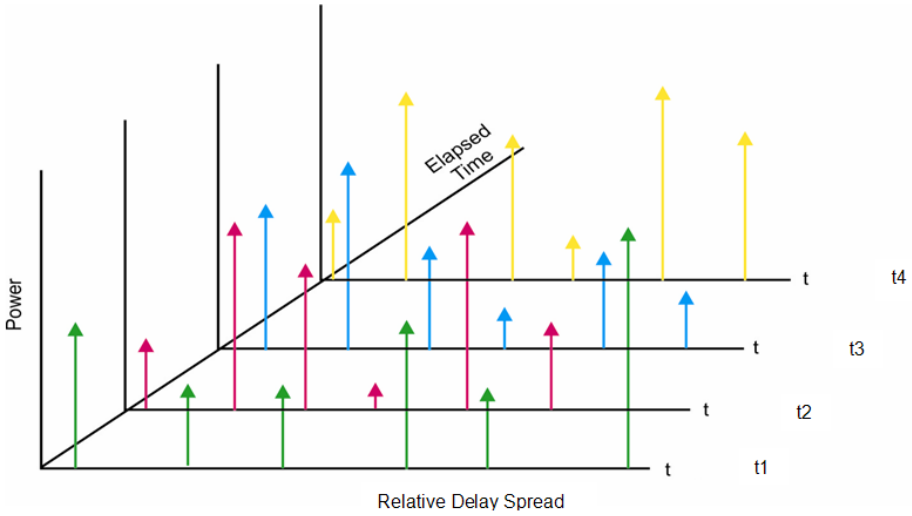


Figure 3-3: 3D Plot Showing Time-Varying PDP

Modern wireless communications systems must adapt to these dramatic changes to continuously mitigate the impact of multi-path delay spread. To accurately evaluate the performance over a time-varying Power Delay Profile, a fading emulator must be able to emulate the time-varying changes in the paths delay characteristics. The following sections describe popularly employed models to emulate dynamic delay spread.

3.4.1. Sliding Relative Path Delay

Popular channel models feature Power-Delay Profiles with time-varying delay spread to evaluate a receiver's ability to adapt to dynamic changes in the radio environment caused by mobility. These models may specify the use of paths with sliding delay characteristics. 3GPP test specifications define Moving Propagation channel models that utilize paths that possess sliding delay with a sinusoidal variation in delay spread. SR5500 sliding delay emulation smoothly varies the temporal location of individual multi-path components using a periodic sinusoidal function. A two-path example is shown in Figure 3-4 below. In this example, Path 1 has fixed delay (t_0) while Path 2 has sliding delay oscillating over the delay range of $\Delta\tau$.

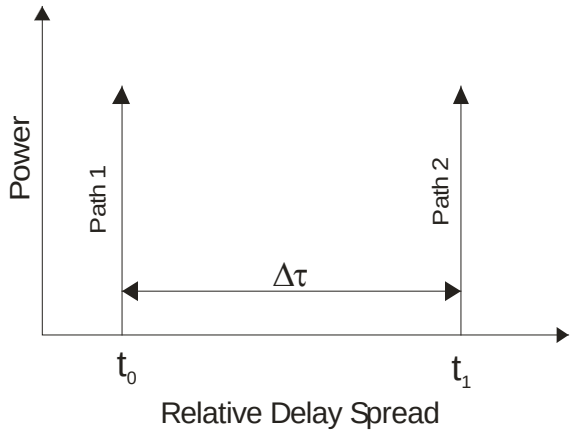


Figure 3-4: Sliding Delay Example

Several parameters must be defined for paths employing sliding delay, including:

- Minimum Delay – minimum delay of the sliding path
- Maximum Delay – maximum delay of the sliding path
- Rate of Oscillation – rate of sliding delay change
- Delay Period – time of one sliding delay period

3.4.2. Birth-Death Time-varying Relative Path Delay

As an alternative to changing the delay spread of a path by sliding the path along the delay axis, some channel models employ Birth-Death time-varying delay emulation. The Birth-Death emulation method randomly varies the location of the paths in the Power Delay Profile along the delay-spread axis. Paths take turns hopping between pre-defined delay spread bins. An example Birth-Death sequence is illustrated in the series of power-delay profiles found in Figure 3-5.

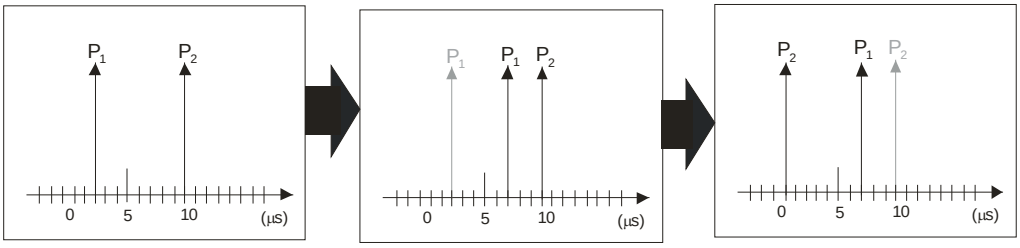


Figure 3-5: Birth-Death Delay Example

Birth-Death paths have fixed delay value during each defined state but change delay value during a state change. Birth-Death paths participate in the Birth-Death sequence by taking turns changing their location along the delay spread axis. During each state, only one path changes its temporal delay location. This "death" of the path in its current delay bin and subsequent "birth" in a new unoccupied bin is performed using a uniform random distribution. You define the individual delay bins that make up the distribution set.

Several parameters must be defined for paths participating in the Birth-Death sequence. These include:

- **Number of Bins**: Defines the number of bins that paths configured for Birth-Death delay will hop between.
- **State Duration**: Defines the time between delay state changes.
- **Delay Bin Values**: Defines the location of the individual delay bins used in the Birth-Death sequence.

3.5. Relative Path Loss

Relative path loss is a phenomenon where individual signal paths arriving at the receiver are at different absolute power levels. The difference in power levels between paths is caused by the physical obstructions in the signal path. Referring to Paths (A) and (C) in Figure 3-6, Path (C) arrives at a lower power level then Path (A). This occurs since some amount of the power in signal Path (C) is lost when it reflects off the truck. Signal strength also varies due to the distance the signal travels. The loss of signal strength should follow the $1/d^2$ law in free space, where d is the distance between the transmitter and the receiver. In the actual cellular environment the loss is much worse, (between $1/d^3$ to $1/d^6$), due mainly to variations in the terrain.

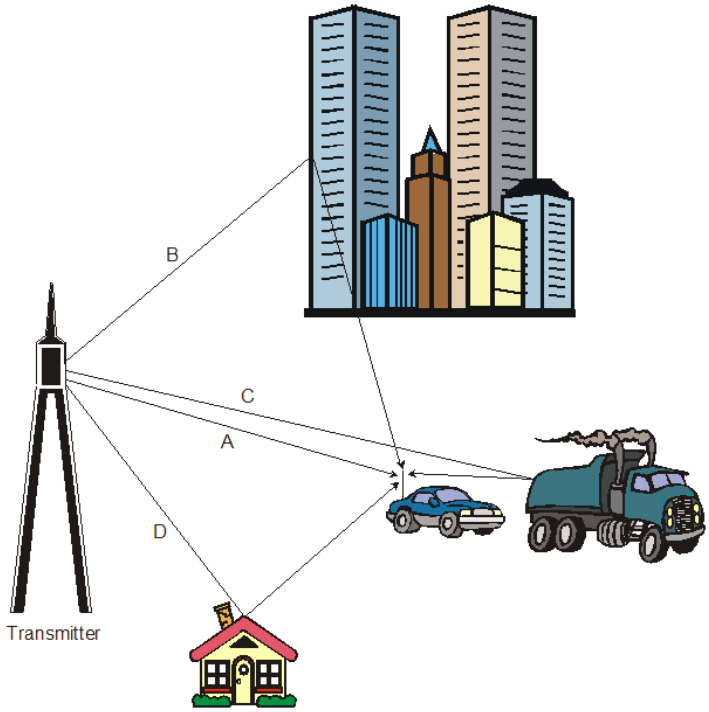


Figure 3-6: Transmitter to Receiver Signal Diagram

3.6. Fast Fading

Fast fading is generated by local scattering of the individual paths in the Power-Delay Profile in close proximity to the receiver. This scattering creates a large number of reflected signal transmissions that arrive at the receiver at relatively the same time (with respect to the inverse of receive signal bandwidth) with random phase and amplitude caused by the difference in distance traveled. Several different mathematical distributions are commonly used to model the amplitude and phase characteristics of the fast fading phenomena. These include the Rayleigh and Rician fast fading amplitude distributions.

3.6.1. Rayleigh Fading Amplitude Distribution

Fast fading is commonly referred to as Rayleigh fading. A Rayleigh modulated signal is caused by scattering of the paths in the Power-Delay Profile from man-made and natural obstacles such as buildings and trees in the local geographical area (within a few hundred wavelengths of the receiver). It is formed by a large number of these scattered (reflected) signals combining at the receiver. Each of these signals has a random phase and amplitude at the receiver due to the reflections and difference in distance traveled.

The phenomenon that creates Rayleigh fading can be easily illustrated using a simple two path example. At the receiver the two paths can be of any amplitude and phase. If the two paths are of the same amplitude, and their phase is 180^{o} apart, there will be total destructive interference and no resultant signal. If the two signal paths are 0^{o} apart in phase there will be constructive interference and the signal envelope will be 3 dB larger than the individual path's amplitudes.

The signals rarely combine to greater than 10 dB above the individual path's power. The deep fades (destructive interference) would range from just a few dB to fades of greater than 50 dB. The spacing and amplitude of the fades are a function of the carrier frequency. At 900 MHz the deep fades will occur at the mobile every few centimeters apart.

The fades and peaks of the signal envelope follow a Rayleigh distribution. This causes the signal strength to fluctuate rapidly between slightly higher levels to deep fades of greater than 50 dB. Figure 3-7 shows an example of the Rayleigh faded signal versus time. Rayleigh fading is called fast fading since the fluctuations are so rapid, as compared to log-normal or slow fading.

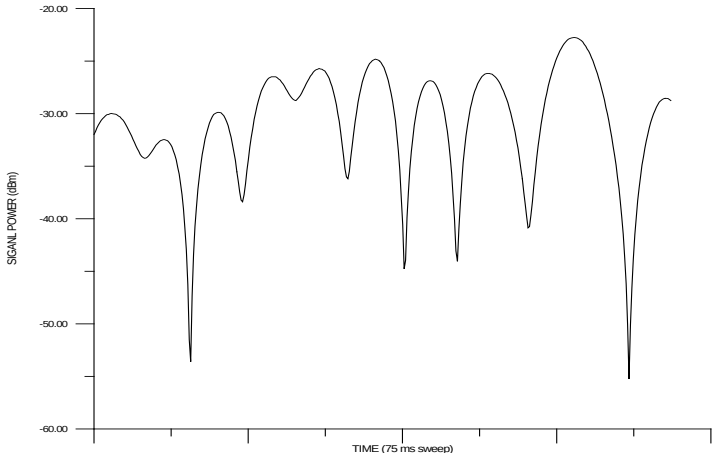


Figure 3-7: Rayleigh Faded Signal vs. Time

- Doppler Freq. = 100 Hz
- Center Freq. = 900 MHz
- Span = 0 Hz
- RBW = 100 kHz
- Sweep Time = 75 msec

The Rayleigh distribution is generated using a complex I/Q modulator. The I/Q signals are modulated with two Gaussian distributed signals. Since Rayleigh fading occurs when there is relative movement between the transmitter and receiver, the signal is subjected to a Doppler shift (frequency shift). As a result the spectrum of Rayleigh fading is limited to plus or minus the Doppler frequency (which is a function of the vehicle velocity) assuming that there is an equal probability that the signal is received with an arrival angle anywhere within the range from 0 to 360 degrees. The theoretical power spectral density of a Rayleigh faded signal is shown in Figure 3-8. Also shown, in Figure 3-9, is the measured power spectral density from a SR5500.

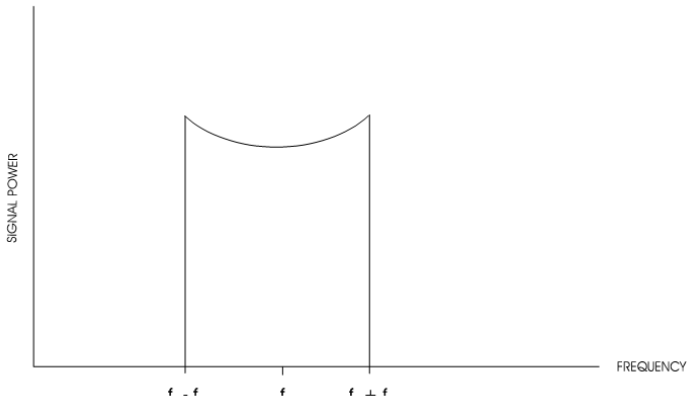


Figure 3-8: Theoretical Rayleigh Power Spectral Density

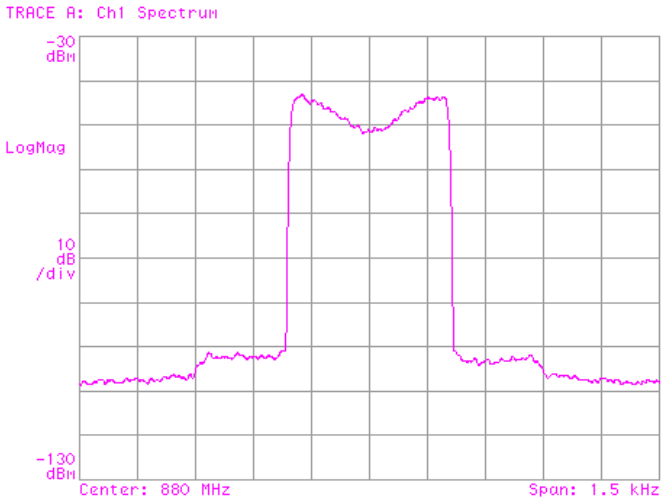


Figure 3-9: Measured Rayleigh Power Spectral Density

- Doppler Freq. = 200 Hz
- Center Freq. = 880 MHz
- Span = 1.5 kHz

To evaluate the performance of Rayleigh fading implemented in the SR5500, it must be compared to a defined standard metric to ensure consistent operation. One set of performance criteria can be found in industry standard test documents. The primary performance criteria that are used to evaluate Rayleigh fading are the Cumulative Probability Distribution Function (CPDF) and the Level Crossing Rate (LCR). Representative fast fading specifications state that an un-modulated carrier with Rayleigh fading should meet the following performance.

The measured Rayleigh (CPDF) should match the calculated CPDF using the following criterion:

1. The measured CPDF of power shall be within ±1 dB of the calculated CPDF from +10 dB above the mean power to 20 dB below the mean power.
2. The measured CPDF of power shall be within ±5 dB of the calculated CPDF from 20 dB to 30 dB below the mean power.
3. The measured LCR should match the calculated LCR, and not deviate more than ±10% of the simulated vehicle speed over a range of 3 dB above the mean power level to 30 dB below the mean power level.

The theoretical and measured CPDF are shown in Figure 3-10. This plot is the probability of a signal level being less then the mean level. The LCR plots, shown in Figure 3-11, are the number of crossings per second versus the signal power. In both of these plots the signal power is relative to the mean. The CPDF and LCR were taken with an 80 Hz Doppler frequency. Both plots show the measured performance of the SR5500 well exceeds the above standards for Rayleigh fading.

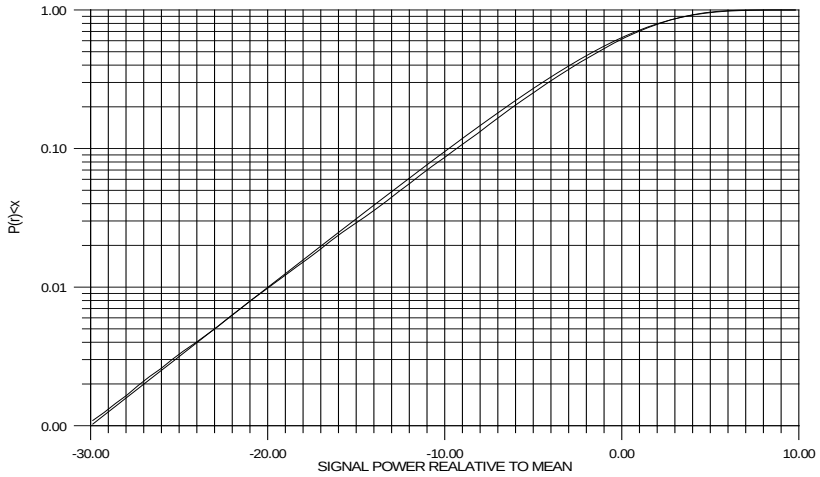


Figure 3-10: Measured vs. Theoretical CPDF

_____Measured
_ _ _ _ Theoretical

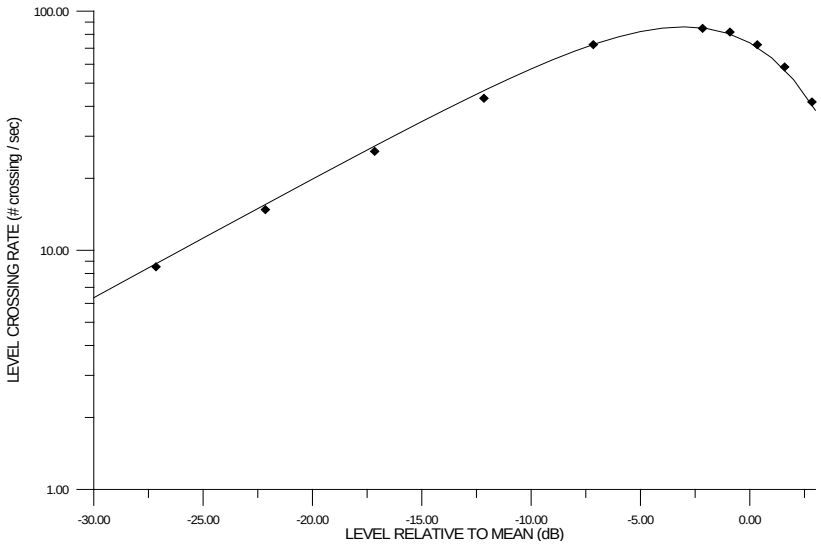


Figure 3-11: Measured vs. Theoretical LCR

♦ ♦ ♦ ♦ Measured

_ _ _ _ _ Theoretical

3.6.2. Rician Fading Amplitude Distribution

Rician fading is formed by the sum of a Rayleigh distributed signal and a Line-Of-Site (LOS or direct path) signal, where the LOS signal is typically subjected to a static frequency shift (static Doppler). A fading environment typically associated with Rician fading is that where one strong direct path reaches the receiver at roughly the same delay as multi-path from local scatterers.

The SR5500 supports the general case of Rician fading with programmable Angle of Arrival (AOA) and K factor. In the general case of Rician fading the arrival angle of the LOS path at the receiver is programmable, as is the ratio of power between the LOS path and the multi-path. The SR5500 provides access to both the LOS arrival angle specified as the AOA (expressed in degrees) and the LOS path to multi-path power ratio specified as the K factor (expressed in dB). Changing the LOS arrival angle will move the relative location of the direct path with respect to the faded spectrum by changing the static Doppler shift of this component. This Doppler shift is set according to the following equation:

$\text{Doppler}_{\text{direct component}} = \text{Doppler}_{\text{faded component}} \times \text{cosine (LOS arrival angle)}$

The K factor setting then controls the relative power of the direct path and the multi-path and has a valid range of -30dB (faded spectrum will dominate) to +30dB (LOS signal will dominate).

An example configuration of Rician fading may have an angle of arrival of the LOS signal path set to be 45º, resulting in a Doppler shift that is ~0.707 of the maximum Doppler shift of the Rayleigh distributed signal (classical Doppler spectrum). Furthermore, if the signal power of Rician fading is split equally between the LOS and multi-paths (where the power envelope of the multi-paths combine to from a Rayleigh distribution) this corresponds to a K factor setting of 0 dB. A theoretical power spectral density for this example of Rician fading is shown in Figure 3-12 and a measured spectral density is shown in Figure 3-13.

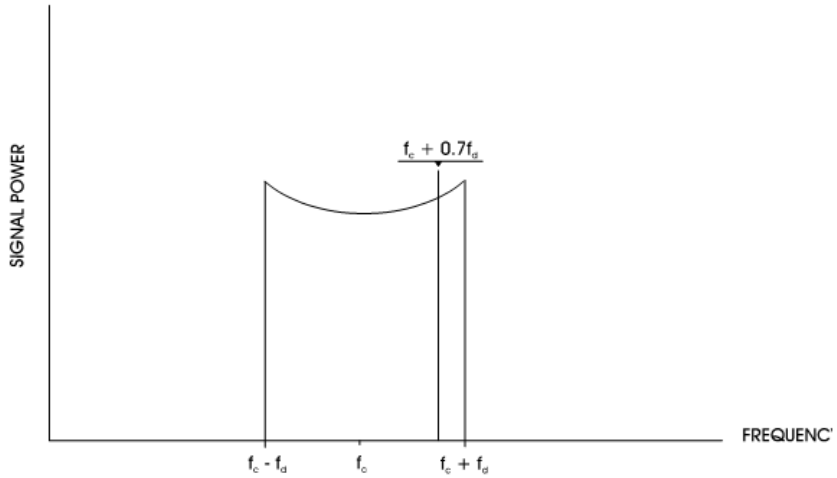


Figure 3-12: Theoretical Power Spectral Density for Rician Fading

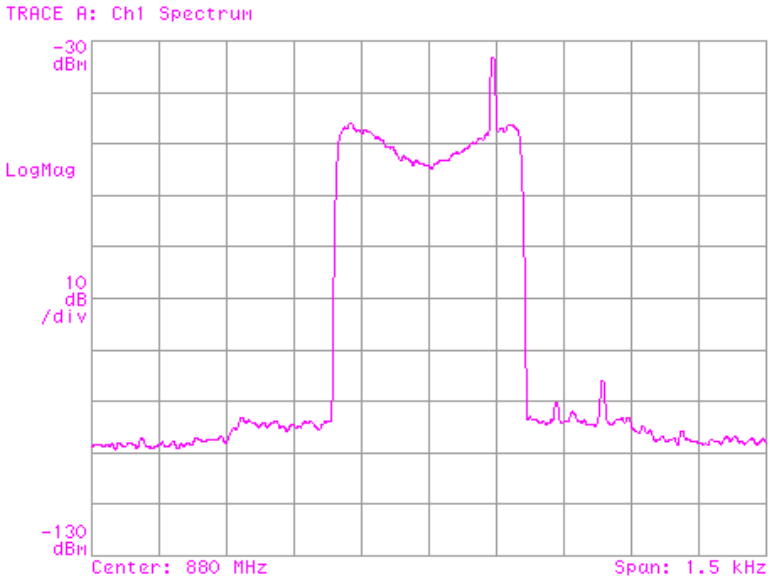


Figure 3-13: Measured Rician Fading Power Spectral Density

- Doppler Freq. = 200 Hz, K = 0 dB
- Center Freq. = 880 MHz
- Span = 1.5 kHz

3.6.3. Fast Fading Power Spectrum Shapes

Rayleigh fading and Rician fast fading describe the amplitude distribution of the faded signal. However, several different frequency domain models can be used to represent the power spectrum shape produced by multi-path fading.

The SR5500 allows you to select the shape of the power spectrum produced by multi-path fading. The four possible spectrum shapes that can be set are shown in Figure 3-14. The first shape, Classical 6 dB is the most commonly used model and adheres to the spectral requirements detailed in many mobile communications standards for Rayleigh fading conditions. The Flat spectrum shape has been determined to be representative of the multi-path propagation effects experienced in some indoor applications. The Classical 3 dB, Rounded and Rounded 12 dB spectrum shapes are also available in the SR5500.

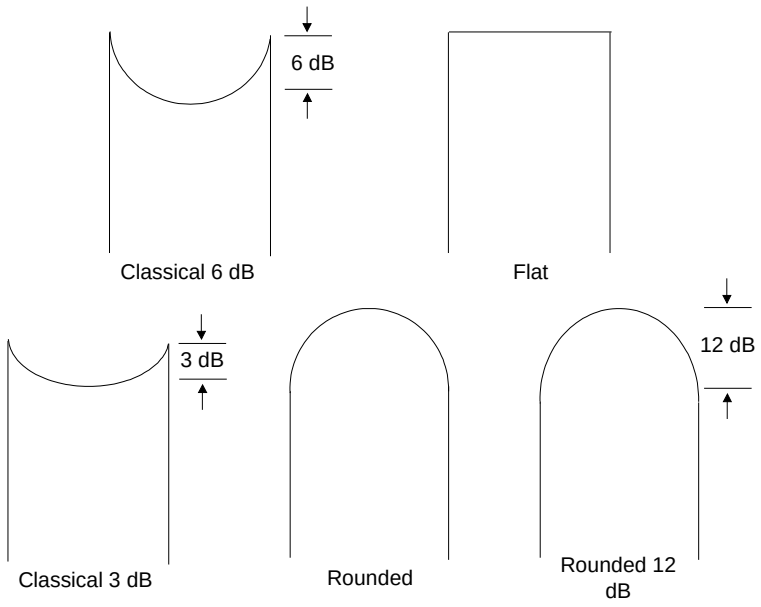


Figure 3-14: Fading Power Spectrum Shape

3.7. Static Amplitude Channel Effects

In some cases, it is desirable to emulate single reflected paths that do not undergo local multi-path scattering and thus have static, or constant, amplitude. While these paths have fixed amplitude versus time, they may be subjected to constant or time-varying phase modulation. These phase modulation effects are described in the following sections.

3.7.1. Frequency Shift (Static Doppler)

Static frequency shift from the carrier frequency occurs when the distance between the receiver and transmitter is changing. An example of this is when a mobile receiver (car) is driving away from the transmitter. Path (A) in Figure 3-6 has a static frequency shift due to the movement of the car. The amount of the frequency shift (Doppler frequency) from the carrier is determined by the following formula:

$$\text{Freq}_{\text{Doppler}} = \frac{\text{Velocity}_{\text{mobile}} \times \text{Freq}_{\text{carrier}}}{\text{C}}$$

where:

C ≅ Speed of Light (3 x 10^8 m/s)

The Doppler frequency, caused by dynamic rotation of the path phase, can be either positive or negative depending whether the mobile receiver is moving away from or towards the transmitter respectively.

3.7.2. High Speed Train Frequency Shift

At the high speeds, both the Doppler shift and the rate of change of Doppler shift are very large, making it very difficult to maintain a mobile connection. Since one of the 3GPP's goals is to maintain mobility up to 350 km/h, HST tests are included in the 3GPP standards. The High Speed Train model focuses on a signal's Doppler Shift as a User Equipment (UE) in a high speed train (300 -350 km/h) passes a Base Station (BS).

The model in the standards for the High Speed Train consists of a single static path whose instantaneous Doppler shift is given as:

$$f_s(t) = f_d \cos\theta(t) \qquad (2.2)$$

Where f_d is defined as:

$$f_d = f_c \frac{v}{C}$$

Where fc is the carrier frequency, v is the speed of the mobile (in m/s) and C is the speed of light ($3x10_8$ m/s).

and cosθ(t) is defined as:

$$\cos\theta(t) = \frac{D_s/2 - vt}{\sqrt{D_{\min}{}^2 + (D_s/2 - vt)^2}}, \quad 0 \le t \le D_s/v$$

$$\cos\theta(t) = \frac{-1.5D_s + vt}{\sqrt{D_{\min}{}^2 + (-1.5D_s + vt)^2}}, \quad D_s/v < t \le 2D_s/v$$

$$\cos\theta(t) = \cos\theta(t \mod (2D_s/v)), \quad t > 2D_s/v \qquad (2.3)$$

where $D_s/2$ is the initial distance of the train from the BS, and $D_{\min}$ is the BS - Railway track distance, both in meters; v is the velocity of the train in m/s, t is time in seconds.

The actual shape of the frequency shift variation depends on the values of f_d, $D_s/2$, D_{min} and v. Figure 3-15 shows the instantaneous frequency shift for D_s=1000 m, D_{min}=50m, v=350km/h and f_d=1340 Hz (3GPP TS36.104 Scenario 1).

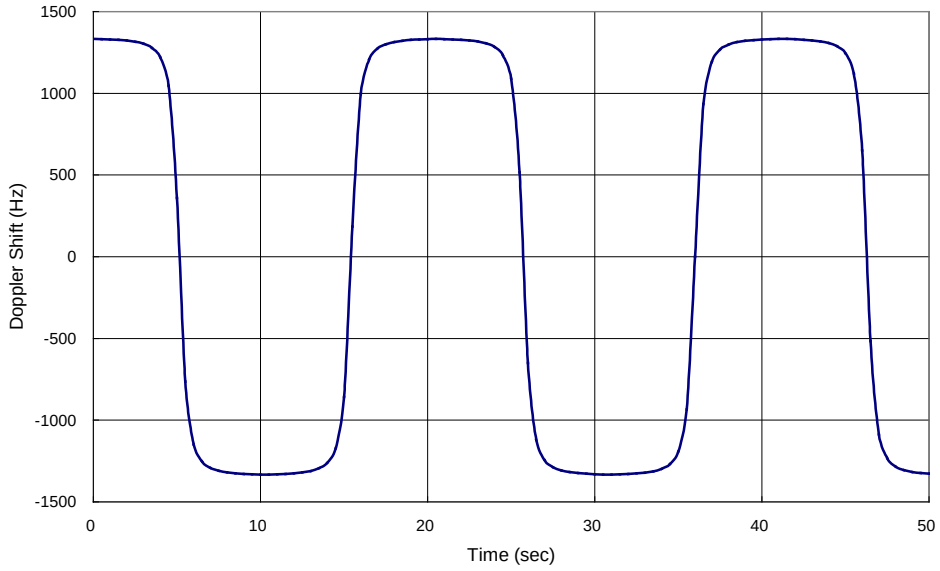


Figure 3-15: High Speed Train Frequency Shift vs. Time

3.7.3. Static Phase Shift

A static phase shift is a result of a constant random distance between the transmitter and receiver. This distance is very rarely going to be an integer number of carrier wavelengths; a non-integer value will result in a static phase shift on the signal path. The amount of phase shift can vary between 0 and 360 degrees.

3.8. Slow Shadow Fading

Slow or Shadow fading is the slow variation of the average signal power over time. A plot of signal power versus time for Shadow fading is shown in Figure 3-16. Shadow fading is often characterized by a log-normal amplitude distribution. The time scale is much larger than that for Rayleigh fading as shown in Figure 3-9. The variation in signal strength at the receiver is due to blockage or absorption of the signal by large-scale variations in the terrain profile and by changes in the nature of the local topography in the path from the transmitter to the receiver. The blockage of the signal is caused by elements in the environment such as hills or a building. This phenomenon is often called shadowing since the receiver is passing through a large "shadow" of an object. An example of this is shown in Figure 3-17 as the mobile receiver (car) passes in the "shadow" of the building, the signal strength would fade.

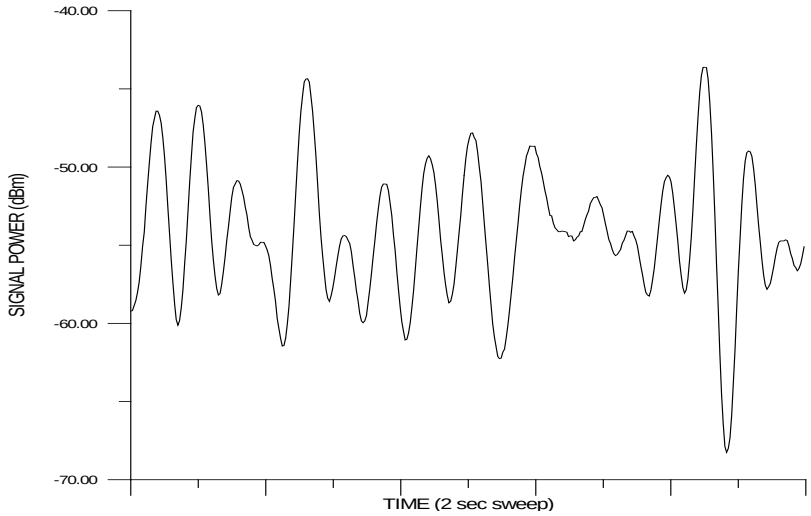


Figure 3-16: Log-Normal Fading vs. Time

- Log-Normal Standard Deviation = 10 dB
- Log-Normal Rate = 10 Hz
- Path Loss = 25 dB
- Center Freq. = 900 MHz
- Span = 0 Hz
- RBW = 100 kHz
- Sweep Time = 2 sec.

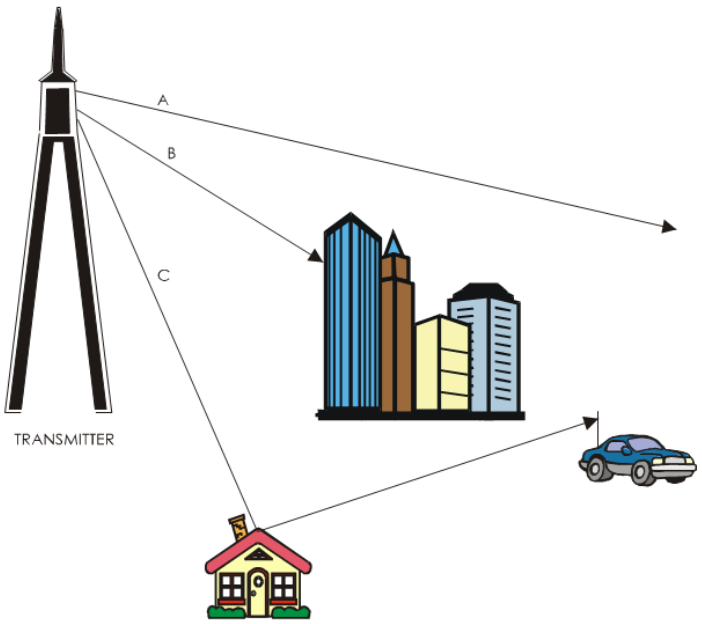


Figure 3-17: Transmitter to Receiver Log-Normal Diagram

This fading has statistical characteristics that are represented by a log-normal distribution of fluctuations in the mean (average) signal power expressed in decibels (dB). The standard deviation of the log-normal distribution is determined by the characteristics of the terrain where the transmitter and receiver are located. For example, a standard deviation of between 6-8 dB is typical for urban areas, while a deviation of 10-12 dB can be observed in rural locations.

The maximum rate of the log-normal fading must also be specified. The rate of log-normal fading is the maximum frequency of the fading spectrum and defines the maximum pace that the mobile will move through the shadow of elements in the terrain. An example can be given of a mobile receiver (car) driving at a fixed speed along a road. If the car is in a rural area behind hills far apart, the log-normal rate would be small since the car is moving through "shadows" at a slow rate. If the car is in an urban area behind rows of buildings, the rate would be larger since the mobile would be passing through "shadows" at a higher rate.

The following relationship holds for log-normal fading:

$$\text{Log Normal Rate (Hz)} = \frac{\text{Mobile Velocity (m / s)}}{\text{Min. Shadow Length (m)}}$$

The log-normal frequency in this equation will be the maximum rate that the mobile will move through "shadows". This corresponds to the maximum frequency of the log-normal fading spectrum that has a span that begins near DC.

3.9. Additive White Gaussian Noise (AWGN) Interferer

The AWGN type of additive interferer is generated independently for each of the two channels of the SR5500. The noise source is defined as being flat over the specified band within the tolerance specified in Section 7.6 on page 252. Refer to Figure 3-18 through Figure 3-22 for plots of typical band-limited noise signal power vs. frequency for each of the available noise bandwidths.

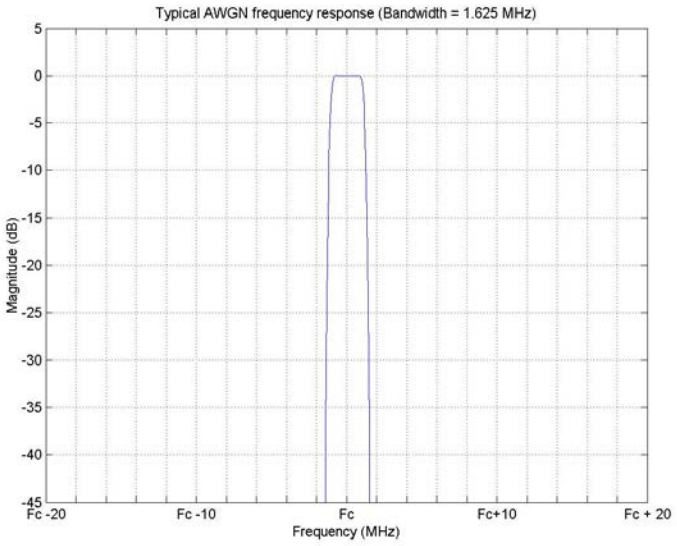


Figure 3-18: Typical SR5500 AWGN Source Power vs. Frequency (1.625 MHz Bandwidth)

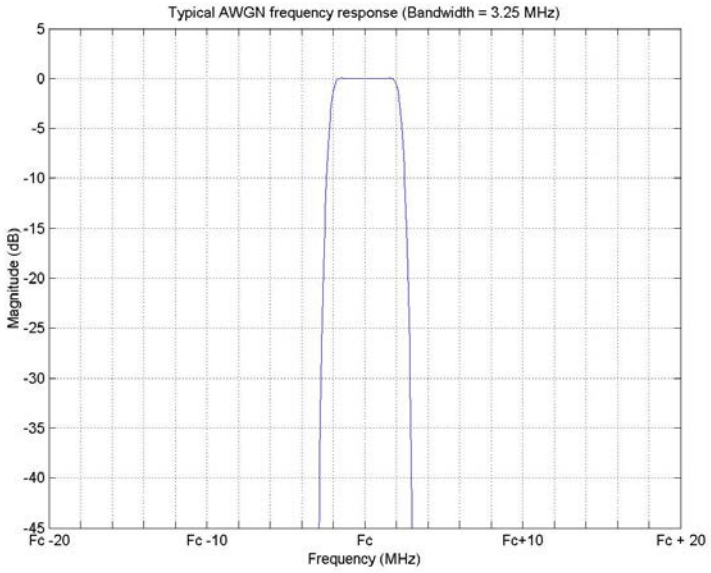


Figure 3-19: Typical SR5500 AWGN Source Power vs. Frequency (3.25 MHz Bandwidth)

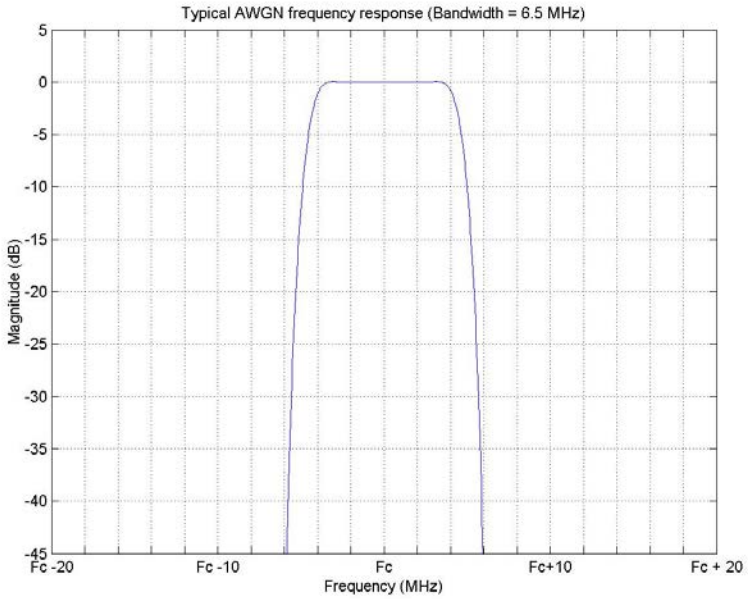


Figure 3-20: Typical SR5500 AWGN Source Power vs. Frequency (6.5 MHz Bandwidth)

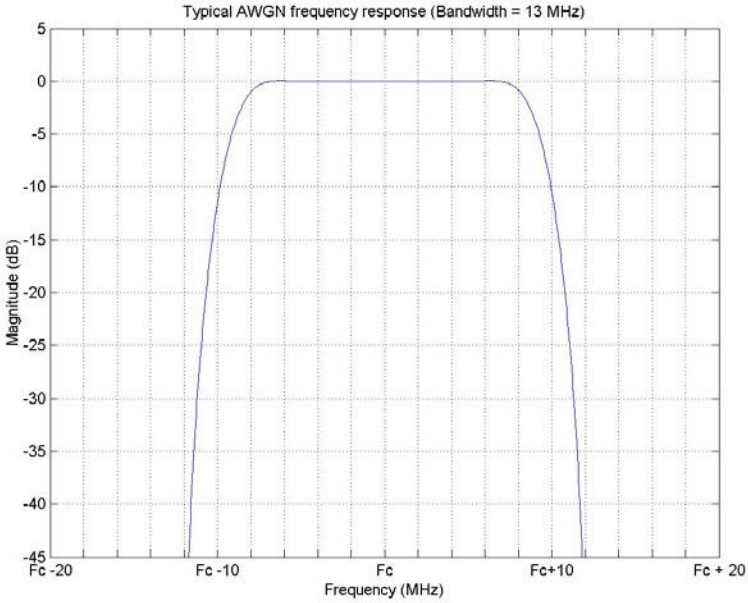


Figure 3-21: Typical SR5500 AWGN Source Power vs. Frequency (13 MHz Bandwidth)

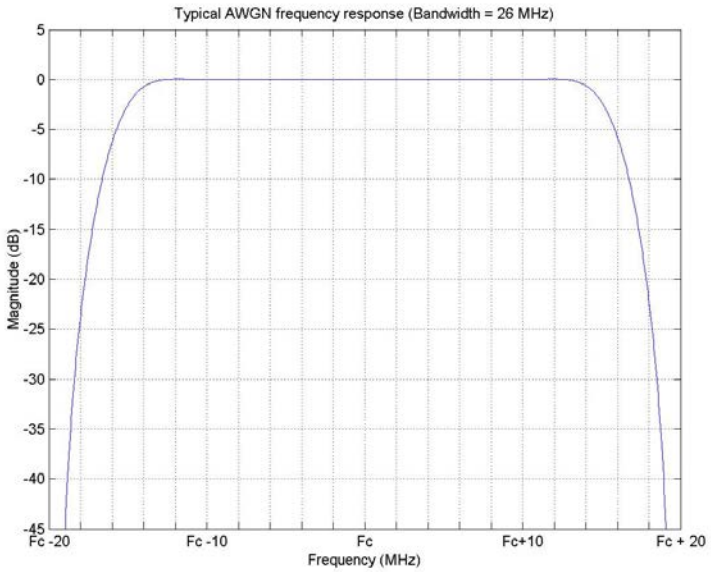


Figure 3-22: Typical SR5500 AWGN Source Power vs. Frequency (26 MHz Bandwidth)

The power of the band-limited noise interferer relative to the carrier power may be specified in one of three ways: carrier to noise, carrier bit power to noise power spectral density and carrier power to noise power spectral density. In carrier to noise (C/N) mode, the power of the band-limited noise is set as a ratio of carrier power to noise in the bandwidth of the receiver. In carrier bit power to noise power spectral density (Eb/No) mode, the power of the band-limited noise is set as a ratio of carrier bit energy to noise power spectral density.

The carrier bit power and noise power in dBm can be calculated based on the following formula:

```
Eb (dBm/bps) = C (dBm) - 10*log10(Bit Rate (bps))
```

where:

```
Eb = Bit power in dBm/bps
C = carrier power in dBm
Bit Rate = bit rate of the carrier
```

and

```
N (dBm) = No + 10 log10 (Receiver Bandwidth)
```

where:

```
N = noise power in the receiver bandwidth in dBm
No = noise power spectral density in dBm/Hz
Receiver Bandwidth = carrier bandwidth in Hz
```

In carrier to noise power spectral density (C/No) mode, the power of the band-limited noise is set as a ratio of carrier power to noise power spectral density. The noise power can be calculated based on the following formula:

```
N (dBm) = No + 10 log10 (Receiver Bandwidth)
```

where:

```
N = noise power in the receiver bandwidth in dBm
No = noise power spectral density in dBm/Hz
Receiver Bandwidth = carrier bandwidth in Hz
```

There is also a dependency between the total output power available and the C/N ratio. Since the SR5500 can produce a fixed amount of total power, large negative C/N ratios reduce the maximum settable output power. The following plot shows the relationship between C/N ratio and output power. The plot assumes that the receiver bandwidth is set to 100% of the noise bandwidth.

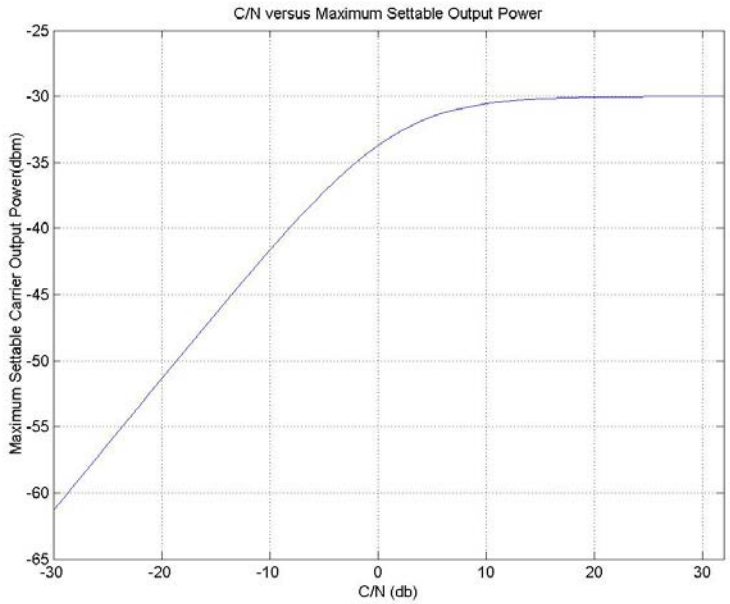


Figure 3-23: C/N vs. Settable Output Power (Receiver Bandwidth – Noise Bandwidth)

Setting the receiver bandwidth to be less then the total noise bandwidth affects this relationship. The following plot shows the relationship for a typical WCMA setup. Noise Bandwidth = 6.5 MHz, Receiver bandwidth set to 3.84 MHz.

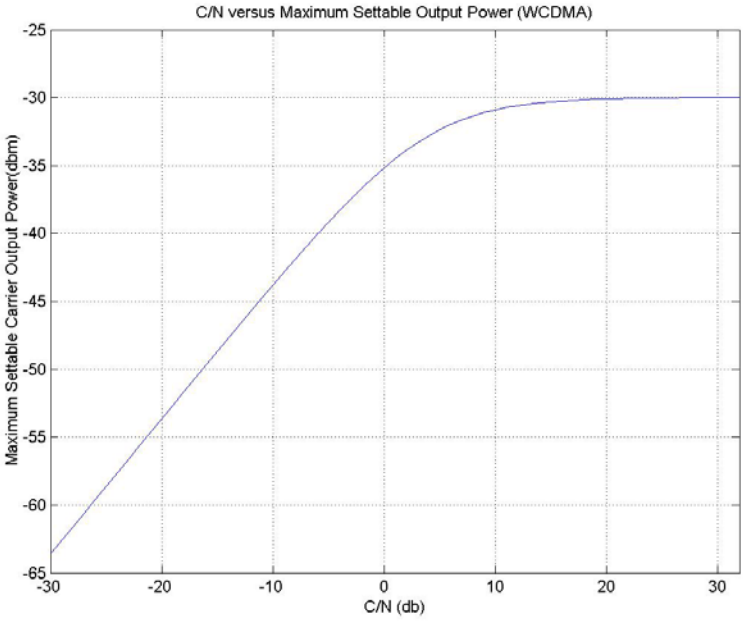


Figure 3-24: C/N vs. Settable Output Power (Receiver Bandwidth = 3.84 MHz, Noise Bandwidth = 6.5 MHz)

The AWGN source is generated using real-time signal generation methods. The AWGN in channel 1 is uncorrelated from the AWGN generated in channel 2. The methods enable band-limited noise generation with very long sequence durations, resulting in excellent statistical properties of peak-to-average ratio and complementary cumulative distribution function (CCDF). Refer to Figure 3-25 for a typical plot of the band-limited AWGN CCDF.

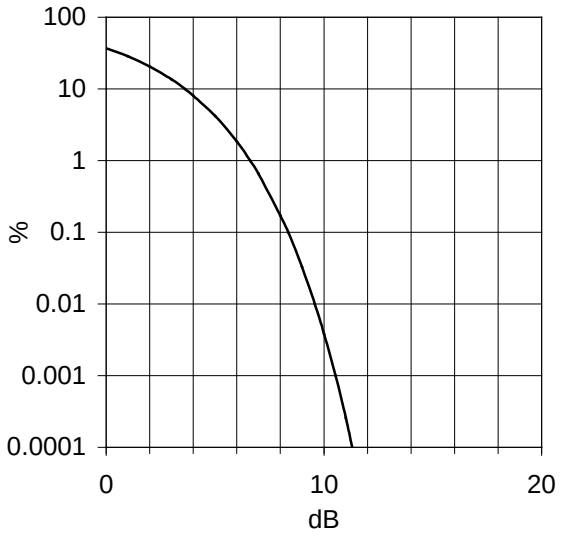


Figure 3-25: Typical SR5500 Band-Limited AWGN CCDF

3.10. Power Meter

The SR5500 contains a Power Meter in each channel that is used to measure the signal levels coming into the unit. The measurement is a wideband power measurement limited by the bandwidth of the SR5500 channel (26 MHz). The Power Meter functions in two modes: continuous and triggered mode.

In the continuous mode of operation, the Power Meter analyzes the input signal at all times. The number of averages that you select defines how many samples of data the meter will sum together before producing a result. Although the Power Meter samples the input signal at 78 MHz, the number of averages parameter refers to blocks of 16 samples. So if the number of averages is set to 2, the actual amount of time that the signal will be sampled before returning a result is:

```
1/78E6 * 16 * 2 = 0.410 µs
```

In the triggered mode of operation, the Power Meter will only analyze samples that are higher in power than the set trigger level. The triggered mode is intended for use in applications where the equipment signal is “bursty”. GSM and WLAN are examples of applications where this mode should be employed. Due to the instantaneous variations in power of communications signals, some filtering must be employed in order to accurately detect when the signal is in the “ON” State.

The following is the criteria that the Power Meter uses to determine whether an individual sample is included in the average calculation:

'A sample will be included in the average if the mean of both the previous eight samples and the next eight samples is greater than the trigger level.'

This approach allows the signal to be measured during only the burst on-time. If the number of averages is large, the measurement will likely take place over multiple 'bursts'. The number of averages in this case refers to the number of included samples. In the case of a signal with a long period between bursts, the measurement can take a significant amount of time. Figure 3-26 shows a block diagram of the triggering approach.

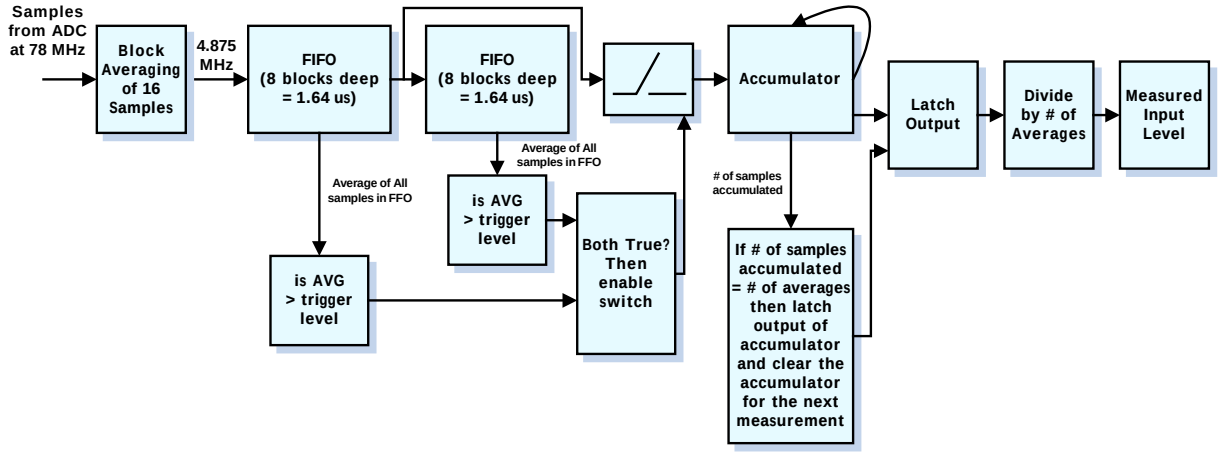

Samples from ADC at 78 MHz
Block Averaging of 16 Samples
4.875 MHz
FIFO (8 blocks deep = 1.64 us)
FIFO (8 blocks deep = 1.64 us)
Accumulator
Latch Output
Divide by # of Averages
Measured Input Level
Average of All samples in FFO
Average of All samples in FFO
is AVG > trigger level
is AVG > trigger level
Both True? Then enable switch
# of samples accumulated
If # of samples accumulated = # of averages then latch output of accumulator and clear the accumulator for the next measurement

Figure 3-26: Triggered Power Measurement Block Diagram

Figure 3-27 displays an example of how the Power Meter collects samples. The input is a 20 MHz wide noise-like signal pulsed on and off at a 20 μs interval. Note that even though some individual samples exceed the set trigger level, they are not included in the measurement because they are too short in duration.

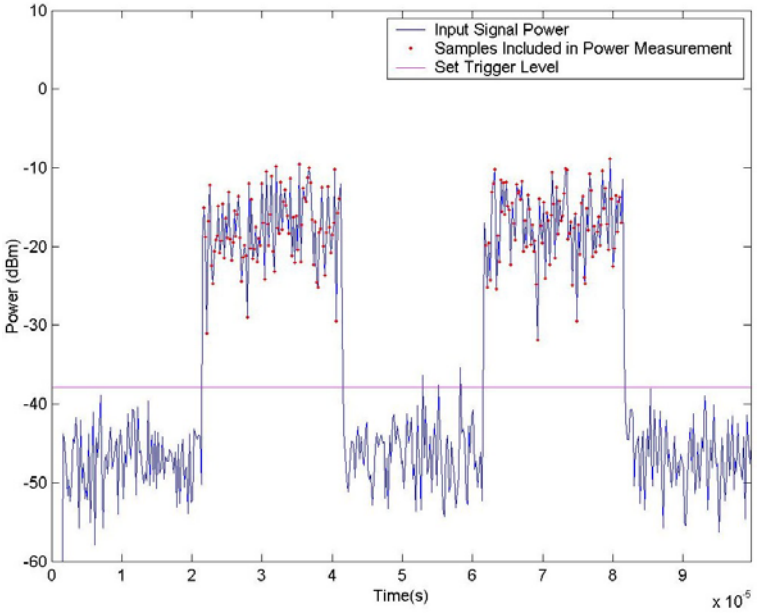


Figure 3-27: Trigger Level

4. Instrument API

4.1. Overview

Spirent Communications provides the SR5500 TestKit application as the Graphical User Interface (GUI) for advanced control of the SR5500 resources. SR5500 TestKit is the recommended control interface for the SR5500. Additionally, Spirent Communications provides the **SR5500 Wireless Channel Emulator Instrument API** (Application Programming Interface). This is provided for developers who want to remotely control the SR5500 directly, for example within proprietary control applications or automated test environments.

Previously, the remote control interface consisted of the proprietary user command set. A remote control application was required to transmit individual commands to the unit to configure it. This required individual development of the drivers. For the SR5500, this remote control interface is replaced with the advanced Application Programming Interface (API) interface. An API is a library of programming objects, routines, and other building blocks provided to a programmer in a widely-accepted format to access resources required for building a complete application. It is no longer necessary to develop your own drivers. The API provides a higher level of functionality than the command set approach and buffers you from the implementation complexities of configuring the unit.

The SR5500 WCE-IAPI is provided in the Dynamic Link Library (DLL) format which is commonly used by developers and easily integrated into any project. A DLL is a collection of small programs that provide access to resources. These programs are only loaded into RAM for use when called upon by the application.

This DLL is released in the form of a .NET DLL. .NET is a Microsoft initiative for next generation software development. .NET is a language-neutral development environment where developed code modules are targeted for the .NET Framework rather than for a particular hardware and operating system combination. As a result a DLL developed in .NET is designed to run on any system supporting the .NET Framework. This Framework consists of a suite of class libraries and a runtime execution engine for .NET-based programs.

NOTE: The SR5500 version 1.20 software release has changed the interface to the Spirent API from "Spirent.WirelessChEmulator" to "Spirent.Gen2.WirelessChEmulator". The older interface will be supported for a limited time to support customers with code compiled with the Rev 1.11 API. This can be done by installing the "binary compatible" API. New users and users in development environments should switch over to the new API immediately and not install the "binary compatible" version.

4.2. Benefits and Features

The SR5500 Instrument API is an advanced Application Programming Interface for remote control of the SR5500, providing substantial advantages over a traditional remote command interface. Some of the benefits of the API are:

- Allows for easy integration of SR5500 control into proprietary instrument control applications, with all the common benefits of development with a DLL in an integrated development environment.
- Simplifies the control of a very complex system with the provision of simple control interfaces which intuitively group parameters and functionality by type; while hiding the complexities of parameter interdependencies, control optimization algorithms, communication details, etc.
- Provides extensive online Hyperlinked help resources.

Specific SR5500 control features include:

- Intuitive partitioning of system, channel and path configuration resources.
- Range and type checking for all parameters.
- Structured error handling and logging.
- Subscribe-able event structure (for parameter dependency warnings, etc.).
- Advanced control mechanisms such as file recall.
- Driver trace utility for development debug.
- Driver and instrument identity and option resources.
- File recall functionality for one-step system configuration.

4.3. Development Environments

The API is released in the form of a .NET DLL (dynamic link library) and is intended for use in a .NET programming environment such as Visual Studio .NET which supports development languages such as Visual Basic .NET, Visual C++ .NET and Visual C# .NET. Use of the API requires installation of the .NET framework.

The DLL can also be used in a COM (Common Object Model; Microsoft's pre-cursor to the .NET Framework) development environment such as Visual Studio 6.0, LabView, LabWindows/CVI etc.

4.4. API Usage Example

The SR5500 API is intuitively designed to facilitate a quick ramp-up for developers adopting the API. To illustrate the ease-of-use of the SR5500 API for configuring the system, the following sample code extract is provided (in VB.NET). The example illustrates the intuitive hierarchical structure, the simplicity of the interface and the descriptive naming convention employed.

This example configures a single RF channel with 2 Rayleigh faded paths, the second path being delayed by 2 μs. Comments are included to explain the upcoming line of code.

```
'instantiate fader object
      Dim myFader As New Spirent.Gen2.WirelessChEmulator.SR5500
'Clear away any currently allocated channel resources
      myFader.ClearChannels()
'create 1 RF channel (RF1input-to-RF1 output); assign all paths to
this channel;
      AddChannel(myFader, ChanInputSourceType.RF1,
ChanOutputSinkType.RF1, 24)
'set a 900MHz Carrier frequency (in Hz); Note that channels are
indexed from ‘0’
      myFader.Channel(0).CarrierFrequency = 900000000
'set input level to -15dBm and output level to -45dBm
      myFader.Channel(0).ChanInputLevel = -15
      myFader.Channel(0).ChanOutputLevel = -45
'Enable 2 paths; Note that paths are indexed from ‘0’ also
      myFader.Channel(0).Path(0).IsEnabled = True
      myFader.Channel(0).Path(1).IsEnabled = True
'enable Rayleigh Fading on both paths:
      myFader.Channel(0).Path(0).ModType = ModulationType.Rayleigh
      myFader.Channel(0).Path(1).ModType = ModulationType.Rayleigh
'set the Doppler Velocity to 8km/h on both paths:
      myFader.Channel(0).Path(0).FadingDoppVelocity = 8
      myFader.Channel(0).Path(1).FadingDoppVelocity = 8
'set delay of the second path to ‘Fixed’ delay with a value of 2us
      myFader.Channel(0).Path(1).DelayMode = DelayModeType.Fixed
      myFader.Channel(0).Path(1).Delay = 2
'Connections Setup: 'set IP address
      myFader.Comm.IPAddress = "192.168.0.7"
'call connect method to connect to unit and have the above
configuration automatically downloaded
      myFader.Comm.Connect()
```

As can be seen in this example, the API is hierarchically and intuitively structured with descriptive naming conventions to allow for easy adoption by developers

4.5. API Front Panel

The SR5500 API includes a utility designed to help verify that the code is configuring the SR5500 properly. This utility is called the API front Panel. The API front panel displays the current state of the API at any moment in time.

4.5.1. Invoking the API Front Panel

To invoke the API Front Panel, call the following API method:

```
MyFader.LauchAPIFrontPanel()
```

This opens the *API Front Panel* window.

NOTE: The API Front Panel Window will open in "minimized" mode. This keeps the API Front Panel from taking up screen real estate until it is required.

4.5.1.1 How the API Front Panel Works

The API Front Panel automatically updates any parameter that you change in the code. If a property is changed, the API will send an event to the API front Panel, which will update this property on its GUI.

You can set and view many of the properties viewable in the API Front Panel. This feature allows you to change these values while in a breakpoint or when deemed necessary. This feature should be used with caution as it is possible to cause issues if the code is running while making changes to the API Front Panel.

The API Front Panel generally responds only to changes in the API, and the measured power levels and overload conditions do not update unless you query these values in the code. The values displayed are the result of the last query. Use the **Refresh** command in the API Front Panel to force a query of these items.

Note that because the API front panel needs to respond to each and every API command sent, it slows the rate of execution of the program. You should use this only when necessary.

4.5.2. The API Front Panel Window Components

4.5.2.1 Main Window

The *Front Panel* window, shown in Figure 4-1, displays general information about the state of the API and the connected SR5500. The current frequency for each channel displays, along with the state of the set and measured input and output levels. The Bypass state also displays.

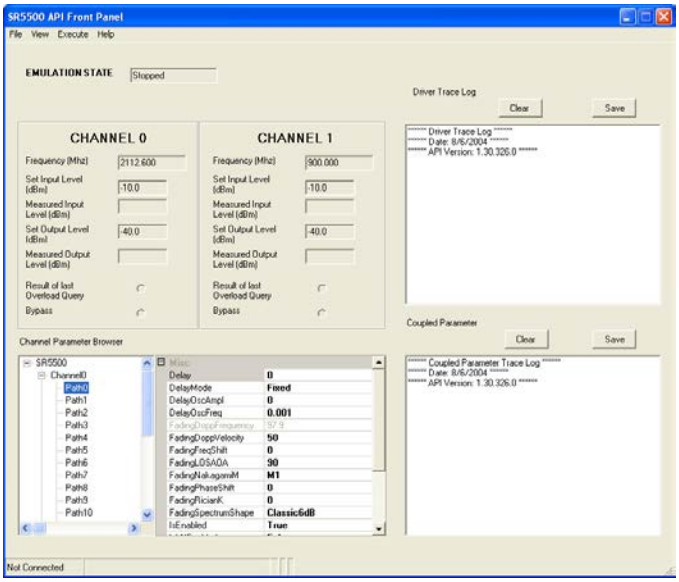


Figure 4-1: SR5500 API Front Panel Window

NOTE: The Measured I/O Levels and the Overload status are not updated continuously. They display the result of the most recent query of these properties by the program. Since monitoring these properties requires a query to the instrument, it is not desirable for the API Front Panel to compete with your code for control of the instrument. To update these values manually, select Execute›Refresh.

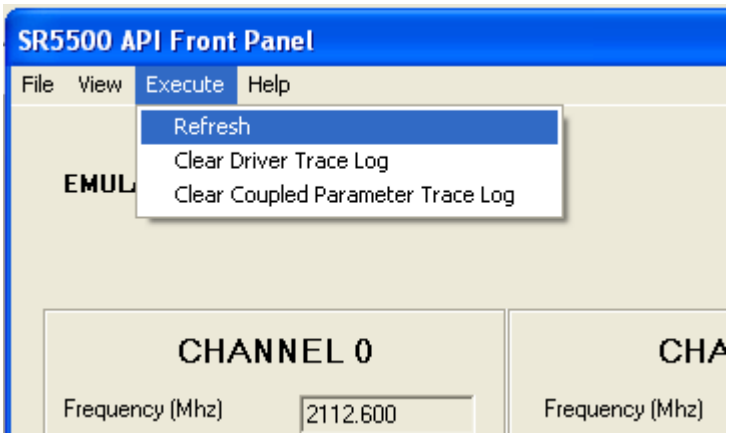


Figure 4-2: API Front Panel – Execute Menu

4.5.2.2 Channel Parameter Browser

The Channel Parameter Browser displays the various channel/path related properties. You can edit and view many of the properties in this window. This should be done with caution.

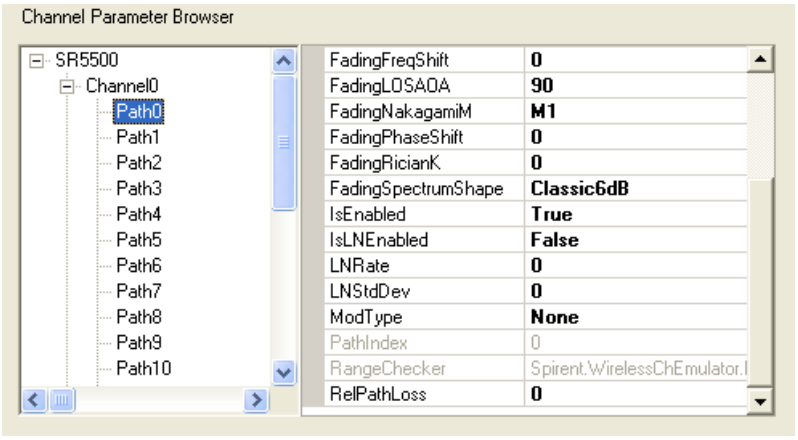


Figure 4-3: Channel Parameter Browser Window

4.5.2.3 View Menu

The View menu, shown in Figure 4-4, provides access to other system level property values, such as AWGN parameters and communication settings.

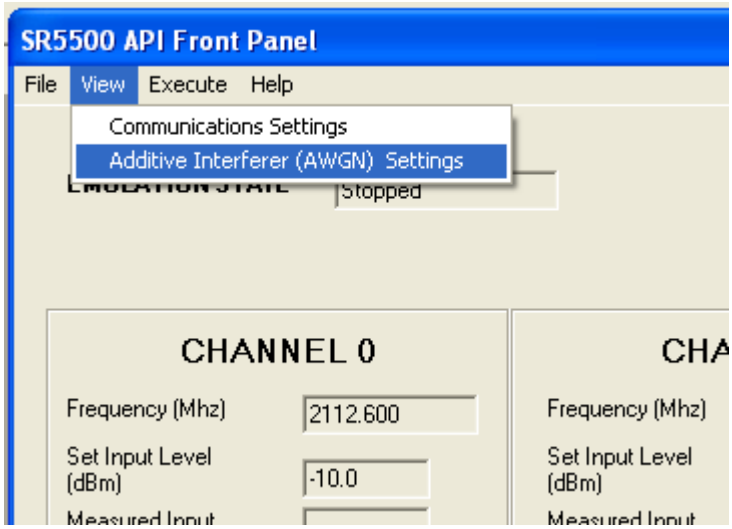


Figure 4-4: API Window – View Menu

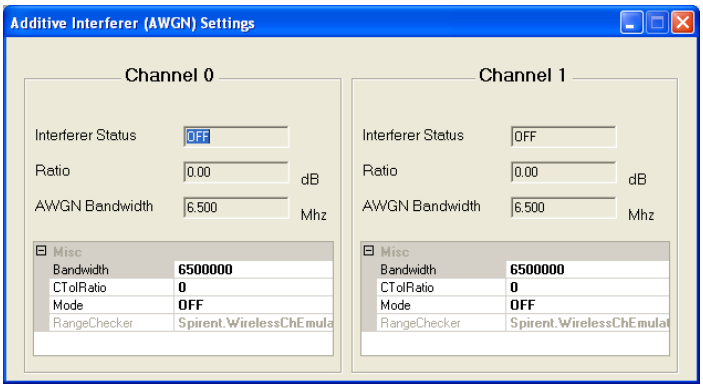


Figure 4-5: AWGN Settings Window

4.5.2.4 Driver Trace Log

The Trace Log provides a printout of the history of commands sent to the API. This helps you debug the application. You can save this Log to a file for future review.

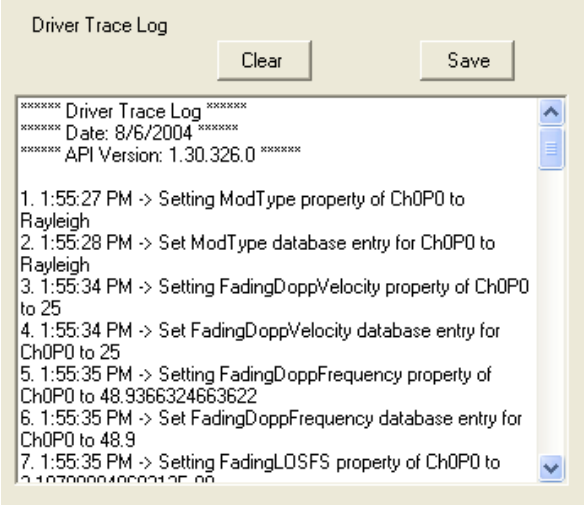

Driver Trace Log
Clear
Save
****** Driver Trace Log ******
****** Date: 8/6/2004 ******
****** API Version: 1.30.326.0 ******
1. 1:55:27 PM -> Setting ModType property of Ch0P0 to Rayleigh
2. 1:55:28 PM -> Set ModType database entry for Ch0P0 to Rayleigh
3. 1:55:34 PM -> Setting FadingDoppVelocity property of Ch0P0 to 25
4. 1:55:34 PM -> Set FadingDoppVelocity database entry for Ch0P0 to 25
5. 1:55:35 PM -> Setting FadingDoppFrequency property of Ch0P0 to 48.9366324663622
6. 1:55:35 PM -> Set FadingDoppFrequency database entry for Ch0P0 to 48.9
7. 1:55:35 PM -> Setting FadingLOSFS property of Ch0P0 to

Figure 4-6: Driver Trace Log Window

4.5.2.5 Coupled Parameter Log

The Coupled Parameter log tracks changes in one property that affect another. For example, if you change the RF center frequency of the channel, the fading Doppler changes to account for this new frequency.

If you change the receiver bandwidth of the AWGN source, it could cause the set C/N ratio to become unachievable. In this case, the API changes the set C/N ratio to the closest achievable value. You can save this Log to a file for future review.

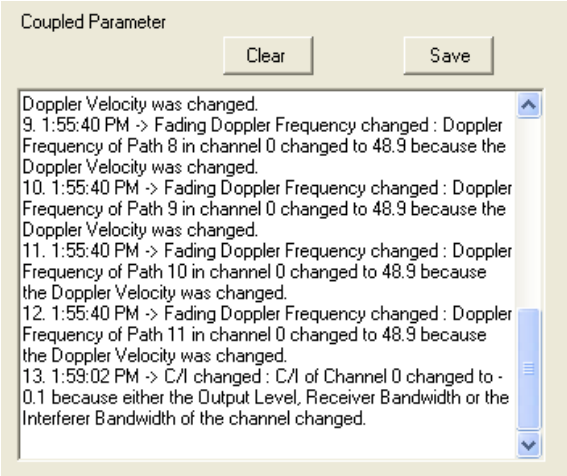

Coupled Parameter
Clear
Save
Doppler Velocity was changed.
9. 1:55:40 PM -> Fading Doppler Frequency changed : Doppler Frequency of Path 8 in channel 0 changed to 48.9 because the Doppler Velocity was changed.
10. 1:55:40 PM -> Fading Doppler Frequency changed : Doppler Frequency of Path 9 in channel 0 changed to 48.9 because the Doppler Velocity was changed.
11. 1:55:40 PM -> Fading Doppler Frequency changed : Doppler Frequency of Path 10 in channel 0 changed to 48.9 because the Doppler Velocity was changed.
12. 1:55:40 PM -> Fading Doppler Frequency changed : Doppler Frequency of Path 11 in channel 0 changed to 48.9 because the Doppler Velocity was changed.
13. 1:59:02 PM -> C/I changed : C/I of Channel 0 changed to -0.1 because either the Output Level, Receiver Bandwidth or the Interferer Bandwidth of the channel changed.

Figure 4-7: Coupled Parameter Window

4.6. Further Information

Additional information about the SR5500 WCE-IAPI can be found in the following electronic documents provided with the API:

- The API Installation Instructions.
- The API Getting Started Instructions.
- The Spirent WCE IAPI Help file. This provides an extensive breakdown of the resources of the API along with links to additional information.

Extensive information on .NET as an initiative, as a Framework and a development environment is available from a myriad of books and web-based resources. The following are some useful related web links to get started:

- http://www.microsoft.com/net/ - Microsoft's homepage on the subject
- http://msdn.microsoft.com/netframework/downloads/howtoget.asp - .NET Framework download site

5. Remote Programming Interface Operation

5.1. Overview

A computer or terminal can control the SR5500 TestKit application by issuing commands through the RS-232, GPIB, or Ethernet remote control ports. The following control link protocols are supported:

- LAN CR/LF
- IEEE 488.2 GPIB

LAN CR/LF (carriage return/line feed) is a simple command-line protocol, and allows you to control TestKit SR5500 application from a terminal or a computer using a TCP/IP socket connection.

GPIB (General Purpose Instrumentation Bus) is the industry-standard parallel-bus instrument control protocol. SR5500 TestKit strictly adheres to the IEEE 488.2 specification.

5.2. Remote Control Features

The Remote Programming Interface gives you the ability to remotely control the TestKit application. Before processing remote commands, you must load the TestKit application and make a connection to the SR5500 Instrument(s). After the first setup, this can be done automatically using a command line option as described in Section 5.3.6 on page 177.

SR5500 TestKit commands and queries are arranged in a tree structure. The top of this tree contains headers, and IEEE 488.2 mandatory commands and queries. Each header can have more headers and Program Messages (commands and queries) under it. For a complete description of all headers and commands, refer to Chapter 6 on page 187.

As described above, SR5500 TestKit command set is made up of IEEE 488.2 mandatory common commands, as well as SR5500-specific commands. These commands loosely adhere to the SCPI protocol. This simplifies learning and using the command set, if you are already familiar with other IEEE 488.2 instruments.

5.3. Configuring SR5500 TestKit for Remote Control

To control the TestKit application remotely, you must configure the Remote Programming Interface(RPI).

5.3.1. Setting up the Remote Programming Interface

Before controlling the SR5500 TestKit from a remote terminal or computer, open the TestKit application and connect to the SR5500 instrument. This is described in Section 2.2.1 on page 26.

After connecting to the instrument, configure the Remote Programming Interface

To configure the remote control configuration:

1. Open the **RPI Configuration Form** located in the *Configuration Menu*.

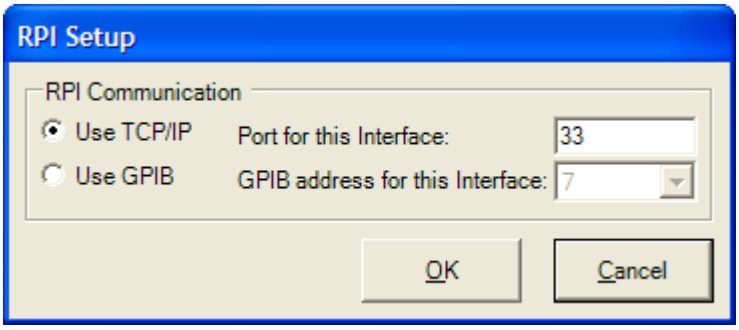


Figure 5-1: RPI Setup Window

2. Select either **TCP/IP** or **GPIB** and the desired **Port** or **Address**.
3. Select the **RPI View** from the *Views Pane*.

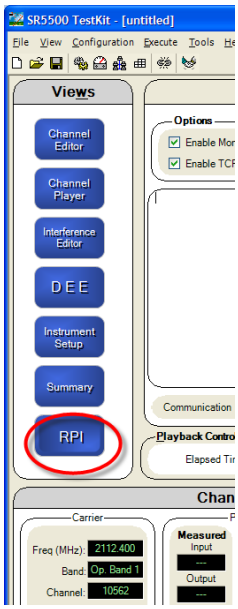


Figure 5-2: RPI View Button

4. In the *RPI View*, select **Start the Listener**.

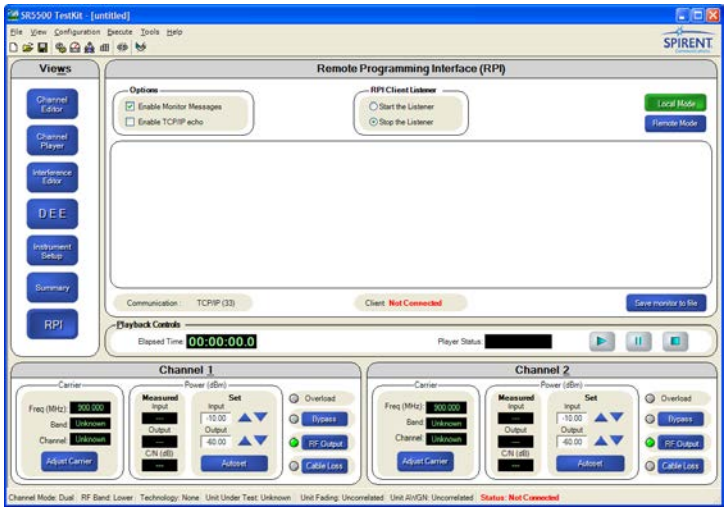


Figure 5-3: RPI View Window

This starts the TCP/IP or GPIB listener. At this point, you can make a connection to SR5500 TestKit, but commands will not be implemented.

NOTE: If the listener is stopped, you will be disconnected.

5. Click the **Remote Mode** button.
   Commands can now be accepted by SR5500 TestKit. In this mode, you cannot exit the RPI view.

6. To exit the RPI view, click the **Local Mode** button.
   This does not disconnect any remotely connected users, but a remote user cannot send commands while in Local Mode. This feature also verifies that SR5500 TestKit is properly setup by the remote commands.

5.3.2. Start/Stop the Listener

Starting the listener allows incoming TCP/IP or GPIB connections to be accepted. Stopping the listener forcibly disconnects any TCP/IP clients.

5.3.3. Local/Remote Mode

To accept remote commands, the SR5500 must be in Remote Mode. While in Remote Mode, you cannot exit the RPI view. If Local Mode is selected, you are able to access all views and menus, but remote commands are not accepted. This allows you to verify that commands sent remotely have properly setup the system. Entering Local Mode, unlike stopping the listener, does not disconnect any connected TCP/IP clients. Enter Remote Mode again manually for the RPI to again accept commands from the remote user.

5.3.4. Enable Monitor Messages

Enabling monitor messages enables the display of status information associated with commands received by the RPI. Disabling these messages increases the speed of command processing.

5.3.5. Enable TCP/IP Echo

When enabled, the RPI echoes back all characters sent to it. This is useful when you manually connect to the RPI via a TCP/IP client and need to view what is being typed. You can disable this function to increase the speed of the parser and to simplify the task of parsing responses from the RPI.

5.3.6. Automatically Configuring SR5500 TestKit for Remote Control

You can open the RPI automatically after the initial setup by adding the following “RPI” command line option when the application is opened.

C:\Program Files\Spirent Communications\SR5500 TestKit\SR5500.exe” RPI

This can be done by either calling the application from a DOS prompt, adding this command to a batch file, or by creating a shortcut to “SR5500.exe” that includes the RPI command line option.

5.4. SR5500 TestKit Command Protocol

5.4.1. Command Types

IEEE 488.2 supports two different program Message Unit types; queries and commands. Queries request a response from the unit being queried. Commands instruct the unit to carry out an action, such as set a parameter or execute a function.

GPIB common commands are defined by the IEEE 488.2 specification so that every unit that supports IEEE 488.2 responds to the command in the same way. Examples of such commands are ***IDN?**, which is query requesting model and revision information and ***OPT?**, which is a query requesting system options from the unit.

Other commands are defined specifically for SR5500 TestKit and loosely follow the SCPI convention. Related commands and queries are grouped together under headers, allowing them to be organized, and thus easier to understand.

5.4.2. Command Sequence

To execute a SR5500 TestKit Program Message Unit, a controller must execute a simple three-step sequence:

1. Check for any pending responses. SR5500 TestKit does not execute a new Program Message Unit if the result from a previous message has not been read.
2. Send the command or query to SR5500 TestKit.
3. After a query is sent, execute a serial poll and then read the query response from SR5500 TestKit.

In the LAN CR/LF protocol, it is not necessary to check for pending responses. The unit automatically queues any responses and error messages.

In the GPIB protocol, responses must be explicitly read back before another query can be sent. In both modes, errors must be explicitly requested using the **:ERR?** query. A common practice is to append a **:ERR?** query after each command.

For example:

```
:CHAN1:PATH1:DELay 10;:ERR?
```

Notice that a semicolon separates the two actions and a colon indicates that the following message should start from the root of the command tree. By sending the above message and reading back the response, you will see any errors that might have arisen.

Default Commands and Headers

Many commands, queries, and command groups have defaults associated with them. For example, under each header, there is a default command, query, or another header which does not have to be explicitly stated in order to be understood. For example, the CHAN1:PATH1:DELay header has many commands under it. The VALue command is the default command. Because of this the following two commands have the same meaning:

```
:CHAN1:PATH1:DELay:VALue 10
:CHAN1:PATH1:DELay 10
```

In the second example, the fact that VALue is being referenced is implied. The same holds true for queries.

5.4.3. Program Messages

A SR5500 TestKit Program Message consists of one or more Program Message Units, which can be Command Message Units (commands) or Query Message Units (queries). IEEE 488.2 dictates that a semicolon (;) separates different Program Message Units sent together in a Program Message. A colon (:) indicates that the program mnemonic for the message being sent starts at the root of the tree.

It is possible to send multiple Program Message Units in a single Program Message, as long as they are separated by a semicolon. Only one query should be present in the message, sending two queries at once causes one response to be lost. You can also send each command or query separately.

The first Program Message Unit within a Program Message does need to start with a colon, since it is assumed that the command starts at the root of the command tree. Subsequent Program Message Units are assumed to reside under the same header as the preceding command, if the next command is not preceded by a colon. The following example shows sending two commands under the same header.

```
:CHAN1:PATH1:DELay 10;MODE FIXed
```

This is equivalent to sending two commands separately

```
: CHAN1:PATH1:DELay 10
: CHAN1:PATH1: MODE FIXed
```

SR5500 TestKit ignores extra white space within the command frame and characters are not case sensitive.

Query Message Units (queries) are Program Message Units which ask SR5500 TestKit to report back a response of some kind, usually a parameter value. Queries have a question mark (?) after the command name like so:

```
: CHAN1:PATH1: DELay:VALue?
```

A possible response for this query might be:

```
10.0000
```

5.4.4. Response Format

IEEE 488.2 Command Message Units (commands) do not generate responses. IEEE 488.2-compliant units only generate responses to Query Message Units (queries). SR5500 TestKit requires you to request the response.

The SR5500 Testkit response format is a headerless format. The Headerless format skips the command header and simply sends the value being requested.

The following is an example of a Headerless response from SR5500 TestKit:

```
Send query: : CHAN1:PATH1:DELay?
Receive response: 10.000
```

5.4.5. Long Form and Short Form of Mnemonics

Every mnemonic has both a long form and short form. You can use either of these forms when sending commands and queries. Typically, the short form of the mnemonic is shown in capital letters with the long form being a combination of the short form plus any lower case letters. IEEE 488.2 dictates that Program Messages can be sent in capital letters, lower case letters, or any combination of the two. An example of the command long and short form is as follows:

```
:CHAN1:PATH1:DELay 10.0
```

The mnemonic called DELay is a command under the PATH1 root command group. Its short form is DEL and its long form is DELay.

The following are valid combinations:

```
:CHAN1:PATH1:DELay 10.0
:CHAN1:PATH1:DEL 10.0
CHAN1:PAtH1:dElAy 10.0
```

The first example shows the first mnemonic using the long form. The second example shows the the short form. The third example shows a combination of upper and lower case letters. The initial colon is implied and skipped.

The following are not valid combinations:

```
:CHAN1:PATH1:DELa 10.0
:CHAN1:P1:DELay 10.0
```

In the first example, the DELay mnemonic is neither in long or short form. In the second example, the PATH1 mnemonic is invalid.

5.4.6. Hierarchical Default Format

There are default sub-mnemonics for many instances of the hierarchical level of a command structure. When these commands are addressed, the default sub-mnemonics need not be explicitly entered. These defaults are presented in square brackets in Chapter 6 on page 187. Use the default sub-mnemonics for both parameter set and query commands.

For example the Channel 1 path 1 delay command is presented as:

: `CHAN1:PATH1:DELay:VALue?`

The current setting for this frequency can be queried in serveral ways:

: `CHAN1:PATH1:DELay:VALue?`

: `CHAN1:PATH1:DEL:VAL?`

: `CHAN1:PATH1:DEL?`

The first example is the long format of the full implementation of the query. The second form is the short form of the full implementation of the query. The third example takes advantage of the defined default sub-mnemonics to shorten the query text.

5.4.7. Error Message Format

The :ERR? Query reports any errors that may have occurred. Errors are reported in the form “ERROR_NUMBER, ERROR_DESCRIPTION”.

The following is a list of possible error responses:

- "0, No error"
- "-256, File name not found" – The specified file does not exist.
- "2, API initialization failure" – Unable to initialize the API
- "3, SR5500 communications failure" – Unable to communicate with the SR5500 hardware.
- "4, SR5500 connection failure" – Unable to connect to the SR5500 hardware.
- "5, File load failure" – Unable to recall WCE File.
- "6, File save failure" – Unable to save WCE FIle
- "11, Autoset in progress" – Unable to execute command because autoset is in progress.
- "12, DEE in progress"– Unable to execute command because DEE is in progress.
- "13, DEE compile in progress"– Unable to execute command because DEE compile is in progress.
- "14, DEE is not supported when a unit (in a suite) is in 4x4 MIMO mode" - DEE is not supported
- "-100, Command error" – Command not understood.
- " -200, Execution error" – Unable to execute command.
- "-222, Data out of range" – Parameter data out of range

- "-224, Parameter error" – Parameter data not understood.
- "-350, Queue Overflow. There is no more room in the Error queue. An error occured but has not been recorded."

5.5. Transmission Layer Protocols

SR5500 TestKit provides two remote control protocol options: LAN CR/LF and IEEE 488.2 GPIB. The command syntax remains the same, regardless of the remote protocol. The remote control protocol determines only the method by which SR5500 TestKit receives commands and provides responses.

5.5.1. LAN CR/LF Protocol

SR5500 TestKit LAN CR/LF mode supports an Ethernet connection using the TCP/IP protocol suite. SR5500 TestKit can be controlled from a TCP/IP socket connection.

TestKit provides a SR5500 prompt when a socket connection is made and ready to receive a command. To enter a Program Message, type the message, then press CARRIAGE RETURN. Note that the unit echoes back each character as it is typed. SR5500 TestKit executes the instruction and provides a response, if necessary. After SR5500 TestKit has processed a command, it sends another prompt to indicate that it is ready to receive a command.

5.5.2. GPIB Protocol

SR5500 TestKit GPIB protocol supports a parallel bus control architecture in which SR5500 TestKit is one of the devices being controlled. The PC running SR5500 TestKit must have a GPIB card installed for this to work. The controller must connect to the PC running SR5500 Testkit (not the SR5500 Instrument) to control SR5500 TestKit. The controller must meet all GPIB electrical and mechanical specifications.

The controller initiates all GPIB protocol transactions. To communicate with SR5500 TestKit, a GPIB controller must perform the following operations:

- Poll SR5500 TestKit for a pending response.
- Send a Program Message to SR5500 TestKit.
- If the message was a query command, poll SR5500 TestKit for the command response.

SR5500 TestKit provides a GPIB status byte to indicate its current state. Possible states include:

- Ready (no events registered) - 00H
- Message Available (no events registered) - 10H

Ready indicates that SR5500 TestKit does not have a message to send and is ready to accept a command. If the unit is processing a previous command, it indicates a ready state, but will not accept the command until it is done processing. Because of this, it is important to set a timeout value of at least one second, although most commands execute within 100 ms.

Message Available indicates that SR5500 TestKit currently has a message to send to the controller. SR5500 TestKit will only have a message available if one is requested using a query command.

When SR5500 TestKit is ready to respond, it sets the serial poll status to 10 hex. After the controller conducts the read operation, the SR5500 TestKit sets the serial poll status to 00 hex.

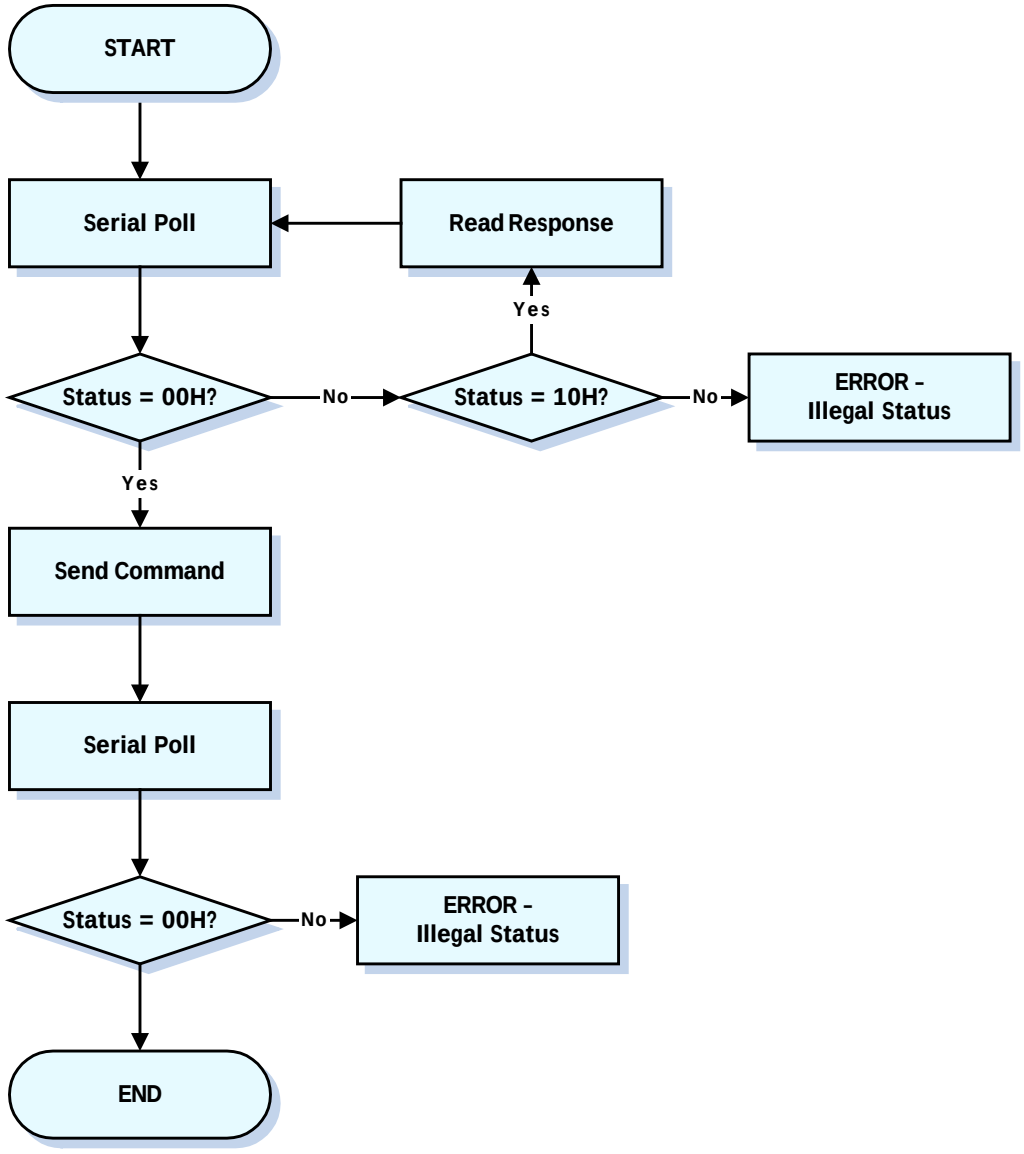


Figure 5-4: Typical Bus Controller Flowchart – Sending GPIB Command

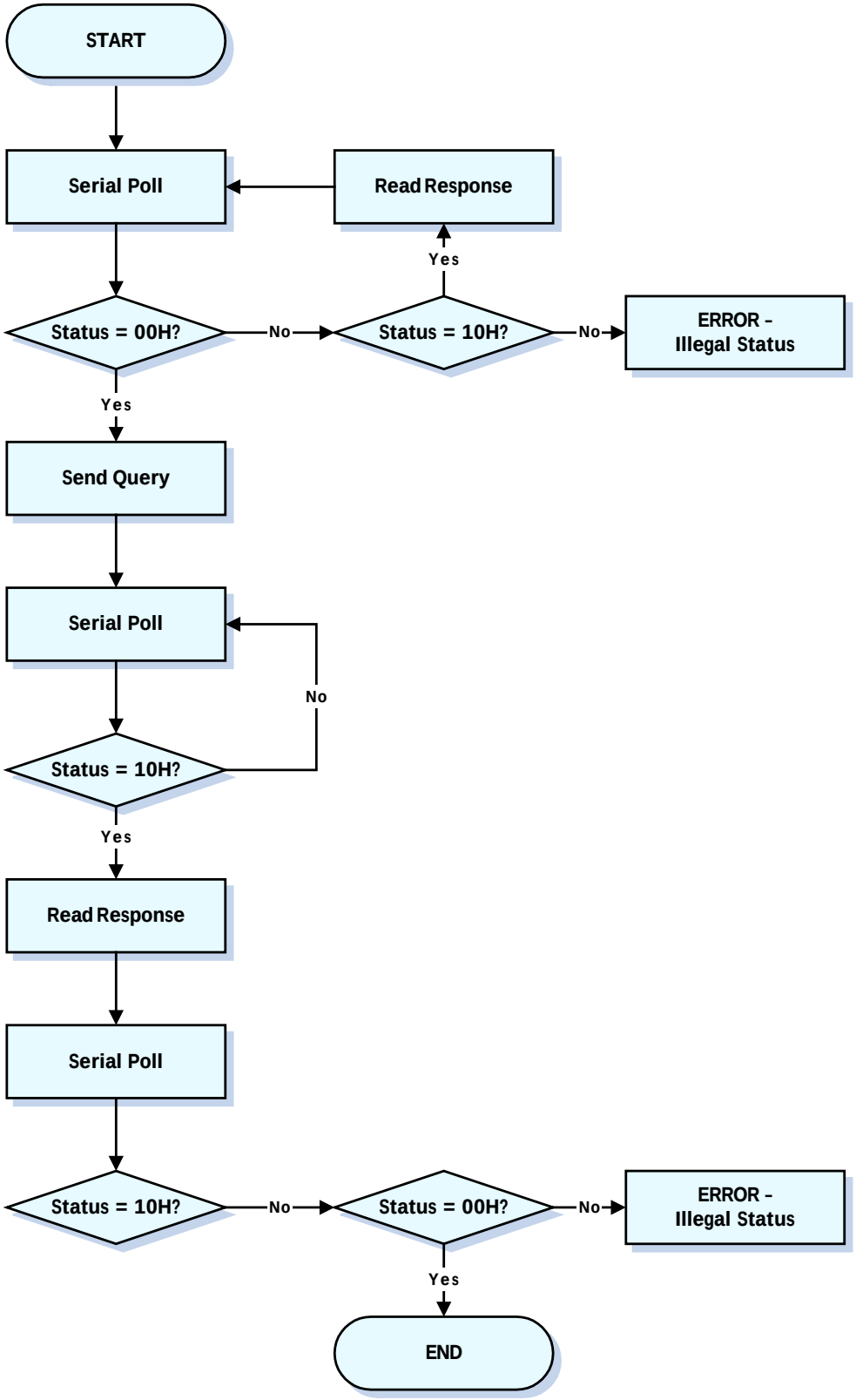


Figure 5-5: Typical Bus Controller Flowchart – Sending GPIB Query

Polling for a Response

The information in the next three sections is provided for reference only. The IEEE-488.1 specification outlines how the GPIB bus and controller hardware must behave. Everything in the following section happens automatically when using a GPIB interface card, GPIB integrated circuit, or SR5500 TestKit.

The controller must conduct a serial poll to receive a command response from SR5500 TestKit. The following example shows the typical GPIB sequence required to achieve a serial poll of SR5500 TestKit. The actual bus sequence may be different.

- ATN active
- UNT - (UNTalk)
- UNL - (UNListen)
- SPE - (Serial Poll Enable)
- MTA - (SR5500 TestKit My Talk Address)
- Controller programmed to listen
- ATN inactive
- SR5500 TestKit sends status
- ATN active
- SPD - (Serial Poll Disable)
- UNT - (UNTalk)

Always conduct a serial poll before sending a command to the unit. If it has a pending message to send, sending another command causes the pending message to be lost..

Sending Commands to SR5500 TestKit

The following example shows the typical GPIB sequence required to send a command to SR5500 TestKit. The actual bus sequence may be different.

- ATN active
- UNT - (UNTalk)
- UNL - (UNListen)
- MLA - (SR5500 TestKit My Listen Address)
- Controller programmed to talk
- ATN inactive
- Controller sends command to SR5500 TestKit and asserts EOI with last command character
- ATN active
- UNL - (UNListen)

Command strings must not be terminated with **CARRIAGE RETURN** or **CARRIAGE RETURN+LINE FEED**. Signal the end of a command message by asserting EOI (end of interrupt) while it sends the last character of the message.

Some commands require several seconds of SR5500 TestKit processing time. While the unit completes most commands in less than one second, some commands may require several seconds. The controller should conduct serial polls until SR5500 TestKit status is ready.

Receiving Responses from SR5500 TestKit

The following example shows the typical GPIB sequence required to receive a command from SR5500 TestKit. Your actual bus sequence may be different.

- ATN active
- UNT - (UNTalk)
- UNL - (UNListen)
- MTA - (SR5500 TestKit My Talk Address)
- Controller programmed to listen
- ATN inactive
- SR5500 TestKit sends data to controller
- Controller reasserts control when EOI goes active
- ATN active
- UNT - (UNTalk)

SR5500 TestKit does not terminate its response message with a **CARRIAGE RETURN** or **CARRIAGE RETURN+LINE FEED**. The unit signals the end of a response message by raising EOI while it sends the last character of the response.

6. RPI Command Reference

6.1. Overview

This chapter is designed to help those who are already familiar with SR5500 TestKit command set to easily find and use commands. The SR5500 TestKit Command Reference provides a complete description of each command group and all commands within each group.

You should be thoroughly familiar with Chapter 3 before attempting to use SR5500 TestKit remote commands. The "Remote Operation" section provides the details of SR5500 TestKit command message format and syntax.

6.2. Conventions to Specify Commands

The SR5500 TestKit supports commands and queries. Commands allow you to set parameters and execute actions, while queries allow you to obtain information from the unit.

Commands are issued to SR5500 TestKit in the format:

:mnemonic1:mnemonic2:…:mnemonicn param1,…,paramn

It is not necessary for commands to have any parameters. Some commands simply execute a function and do not require any parameters.

Query commands require the format:

:mnemonic1:mnemonic2:…:mnemonicn?

The SR5500 TestKit will provide the requested information as:

resp1

Most commands have associated queries associated with them. For example, the command to set the interferer 1 frequency:

:CHAN1:PATH1:DELay 10.0

has a query with the same header and command name:

:CHAN1:PATH1:DELay?

6.2.1. Command Summary

```
*IDN?
*OPT?
*RST
[SUITe:]BAND {LOWer|MIDdle|UPper}
[SUITe:]BAND?
[SUITe:]CORRelation:MATRix[:ALLpaths] <real list>
[SUITe:]CORRelation:MATRix[:ALLpaths]?
[SUITe:]CORRelation:MATRix:PATH# <real list>
[SUITe:]CORRelation:MATRix:PATH#?
[SUITe:]CORRelation:MODe {ENVelope|COMPonent|COMPLex}
[SUITe:]CORRelation:MODe?
[SUITe:]CORRelation:TYPe {INSTrument|SUITe}
[SUITe:]CORRelation:TYPe?
[SUITe:]CORRelation[:UNIT#]:AWGNCorrelation {OFF|ON}
[SUITe:]CORRelation[:UNIT#]:AWGNCorrelation?
[SUITe:]CORRelation[:UNIT#]:AWGNValid?
[SUITe:]CORRelation[:UNIT#]:CHCorrelation <real list>
[SUITe:]CORRelation[:UNIT#]:CHCorrelation?
[SUITe:]CORRelation[:UNIT#]:CHCValid?
[SUITe:]CORRelation[:UNIT#]:IMATRix:PATH# <real list>
[SUITe:]CORRelation[:UNIT#]:IMATRix:PATH#?
[SUITe:]CORRelation[:UNIT#]:IMODe {ENVelope|COMPonent|COMPLex}
[SUITe:]CORRelation[:UNIT#]:IMODe?
[SUITe:]DEE:CLOOP?
[SUITe:]DEE:COMPile:ABORt
[SUITe:]DEE:COMPile:BEGin
[SUITe:]DEE:COMPile:FILE# <string>
[SUITe:]DEE:COMPile:STATus?
[SUITe:]DEE:CSTATe?
[SUITe:]DEE:ETIMe?
[SUITe:]DEE:LATency <int>
[SUITe:]DEE:LATency?
[SUITe:]DEE:MODe {WRAParound|ONCE|NUMber}
[SUITe:]DEE:MODe?
[SUITe:]DEE:NUMberloops <int>
[SUITe:]DEE:NUMberloops?
[SUITe:]DEE:NUMSTates?
[SUITe:]DEE[:STATe] {OFF|ON}
[SUITe:]DEE:TRIGtime <string>
[SUITe:]DEE:TRIGtime?
[SUITe:]DEE:TYPe {FREErun|TRIGgered|TIMetriggered}
```

```
[SUITe:]DEE:TYPe?
[SUITe:]ERR?
[SUITe:]FADLab:FDP:ETIMe?
[SUITe:]FADLab:FDP:STATe {OFF|ON}
[SUITe:]FADLab:FDP[:UNIT]:BDOWnload
[SUITe:]FADLab:FDP[:UNIT]:CLOOP?
[SUITe:]FADLab:FDP[:UNIT]:DABort
[SUITe:]FADLab:FDP[:UNIT]:DPRogress?
[SUITe:]FADLab:FDP[:UNIT]:DSTatus?
[SUITe:]FADLab:FDP[:UNIT]:FILE <string>
[SUITe:]FADLab:FDP[:UNIT]:FILE?
[SUITe:]FADLab:FDP[:UNIT]:REPRate?
[SUITe:]FADMode {FNoise|SOS}
[SUITe:]FADMode?
[SUITe:]LOAD <string>
[SUITe:]LOADPDP <string>
[SUITe:]NUMUnits?
[SUITe:]SAVE <string>
[SUITe:]SYNChronize?
[SUITe:][UNIT#:]ASTatus?
[SUITe:][UNIT#:]CHAN#:AABort
[SUITe:][UNIT#:]CHAN#:BAUToset
[SUITe:][UNIT#:]CHAN#:BDEath:DBINs <real list>
[SUITe:][UNIT#:]CHAN#:BDEath:DBINs?
[SUITe:][UNIT#:]CHAN#:BDEath:NUMBins?
[SUITe:][UNIT#:]CHAN#:BDEath:SDURation <real>
[SUITe:][UNIT#:]CHAN#:BDEath:SDURation?
[SUITe:][UNIT#:]CHAN#:BYPass {OFF|ON}
[SUITe:][UNIT#:]CHAN#:BYPass?
[SUITe:][UNIT#:]CHAN#:CBLLoss <real>
[SUITe:][UNIT#:]CHAN#:CBLLoss?
[SUITe:][UNIT#:]CHAN#:CFACtor <real>
[SUITe:][UNIT#:]CHAN#:CFACtor?
[SUITe:][UNIT#:]CHAN#:CLROVerload
[SUITe:][UNIT#:]CHAN#:FREQuency <real>
[SUITe:][UNIT#:]CHAN#:FREQuency?
[SUITe:][UNIT#:]CHAN#:INPPHAse <real>
[SUITe:][UNIT#:]CHAN#:INPPHAse?
[SUITe:][UNIT#:]CHAN#:INPut <real>
[SUITe:][UNIT#:]CHAN#:INPut?
[SUITe:][UNIT#:]CHAN#:INTerferer:BITRate <real>
[SUITe:][UNIT#:]CHAN#:INTerferer:BITRate?
[SUITe:][UNIT#:]CHAN#:INTerferer:CTON <real>
```

```
[SUITe:][UNIT#:]CHAN#:INTerferer:CTON?
[SUITe:][UNIT#:]CHAN#:INTerferer:CTONO <real>
[SUITe:][UNIT#:]CHAN#:INTerferer:CTONO?
[SUITe:][UNIT#:]CHAN#:INTerferer:EBNO <real>
[SUITe:][UNIT#:]CHAN#:INTerferer:EBNO?
[SUITe:][UNIT#:]CHAN#:INTerferer:MODe {OFF|AWGN}
[SUITe:][UNIT#:]CHAN#:INTerferer:MODe?
[SUITe:][UNIT#:]CHAN#:INTerferer:NBWidth <real>
[SUITe:][UNIT#:]CHAN#:INTerferer:NBWidth?
[SUITe:][UNIT#:]CHAN#:INTerferer:RBWidth <real>
[SUITe:][UNIT#:]CHAN#:INTerferer:RBWidth?
[SUITe:][UNIT#:]CHAN#:MEASure:CTON?
[SUITe:][UNIT#:]CHAN#:MEASure:CTONO?
[SUITe:][UNIT#:]CHAN#:MEASure:DCYCle <real>
[SUITe:][UNIT#:]CHAN#:MEASure:DCYCle?
[SUITe:][UNIT#:]CHAN#:MEASure:EBNO?
[SUITe:][UNIT#:]CHAN#:MEASure:IAVGexp <real>
[SUITe:][UNIT#:]CHAN#:MEASure:ILEVel?
[SUITe:][UNIT#:]CHAN#:MEASure:ITYPe?
[SUITe:][UNIT#:]CHAN#:MEASure:OAVGexp <real>
[SUITe:][UNIT#:]CHAN#:MEASure:OAVGexp?
[SUITe:][UNIT#:]CHAN#:MEASure:OLEVel
[SUITe:][UNIT#:]CHAN#:MEASure:OTYPe {CALCulated|MEASured}
[SUITe:][UNIT#:]CHAN#:MEASure:OTYPe?
[SUITe:][UNIT#:]CHAN#:MEASure:TTHReshold <real>
[SUITe:][UNIT#:]CHAN#:MEASure:TTHReshold?
[SUITe:][UNIT#:]CHAN#:NUMPaths?
[SUITe:][UNIT#:]CHAN#:OUTPPHAse <real>
[SUITe:][UNIT#:]CHAN#:OUTPPHAse?
[SUITe:][UNIT#:]CHAN#:OUTPut <real>
[SUITe:][UNIT#:]CHAN#:OUTPut?
[SUITe:][UNIT#:]CHAN#:OVERload?
[SUITe:][UNIT#:]CHAN#:PATH#:DELay:MODE {FIXed|SDELay|BDEath}
[SUITe:][UNIT#:]CHAN#:PATH#:DELay:MODE?
[SUITe:][UNIT#:]CHAN#:PATH#:DELay:SDELay:DMIN <real>
[SUITe:][UNIT#:]CHAN#:PATH#:DELay:SDELay:DMIN?
[SUITe:][UNIT#:]CHAN#:PATH#:DELay:SDELay:DMAX <real>
[SUITe:][UNIT#:]CHAN#:PATH#:DELay:SDELay:DMAX?
[SUITe:][UNIT#:]CHAN#:PATH#:DELay:SDELay:ORATe <real>
[SUITe:][UNIT#:]CHAN#:PATH#:DELay:SDELay:ORATe?
[SUITe:][UNIT#:]CHAN#:PATH#:DELay:SDELay:PERiod?
[SUITe:][UNIT#:]CHAN#:PATH#:DELay[:VALue] <real>
[SUITe:][UNIT#:]CHAN#:PATH#:DELay[:VALue]?
```

```
[SUITe:][UNIT#:]CHAN#:PATH#:DFRequency <real>
[SUITe:][UNIT#:]CHAN#:PATH#:DFRequency?
[SUITe:][UNIT#:]CHAN#:PATH#:DVELocity <real>
[SUITe:][UNIT#:]CHAN#:PATH#:DVELocity?
[SUITe:][UNIT#:]CHAN#:PATH#:FSHAPe {C3DB|C6DB|ROUNd|FLAT|R12DB}
[SUITe:][UNIT#:]CHAN#:PATH#:FSHAPe?
[SUITe:][UNIT#:]CHAN#:PATH#:FSHift[:VALue] <real>
[SUITe:][UNIT#:]CHAN#:PATH#:FSHift[:VALue]?
[SUITe:][UNIT#:]CHAN#:PATH#:FSHift:MODE {FIXed|HST}
[SUITe:][UNIT#:]CHAN#:PATH#:FSHift:MODE?
[SUITe:][UNIT#:]CHAN#:PATH#:FSHift:HST:INIDs <real>
[SUITe:][UNIT#:]CHAN#:PATH#:FSHift:HST:INIDs?
[SUITe:][UNIT#:]CHAN#:PATH#:FSHift:HST:DMIN <real>
[SUITe:][UNIT#:]CHAN#:PATH#:FSHift:HST:DMIN?
[SUITe:][UNIT#:]CHAN#:PATH#:FSHift:HST:VELocity <real>
[SUITe:][UNIT#:]CHAN#:PATH#:FSHift:HST:VELocity?
[SUITe:][UNIT#:]CHAN#:PATH#:FSHift:HST:MAXDoppler <real>
[SUITe:][UNIT#:]CHAN#:PATH#:FSHift:HST:MAXDoppler?
[SUITe:][UNIT#:]CHAN#:PATH#:FSHift:HST:PERiod?
[SUITe:][UNIT#:]CHAN#:PATH#:LOGNormal:RATe <real>
[SUITe:][UNIT#:]CHAN#:PATH#:LOGNormal:RATe?
[SUITe:][UNIT#:]CHAN#:PATH#:LOGNormal:SDEViation <int>
[SUITe:][UNIT#:]CHAN#:PATH#:LOGNormal:SDEViation?
[SUITe:][UNIT#:]CHAN#:PATH#:LOGNormal[:STATe] {OFF|ON}
[SUITe:][UNIT#:]CHAN#:PATH#:LOGNormal[:STATe]?
[SUITe:][UNIT#:]CHAN#:PATH#:LOS:AOA <real>
[SUITe:][UNIT#:]CHAN#:PATH#:LOS:AOA?
[SUITe:][UNIT#:]CHAN#:PATH#:LOS:DOPPler <real>
[SUITe:][UNIT#:]CHAN#:PATH#:LOS:DOPPler?
[SUITe:][UNIT#:]CHAN#:PATH#:LOS:KRICian <real>
[SUITe:][UNIT#:]CHAN#:PATH#:LOS:KRICian?
[SUITe:][UNIT#:]CHAN#:PATH#:MODulation {NONE|RAYLeigh|RICian}
[SUITe:][UNIT#:]CHAN#:PATH#:MODulation?
[SUITe:][UNIT#:]CHAN#:PATH#:PHSHift <real>
[SUITe:][UNIT#:]CHAN#:PATH#:PHSHift?
[SUITe:][UNIT#:]CHAN#:PATH#:RPLoss <real>
[SUITe:][UNIT#:]CHAN#:PATH#:RPLoss?
[SUITe:][UNIT#:]CHAN#:PATH#[:STATe] {OFF|ON}
[SUITe:][UNIT#:]CHAN#:PATH#[:STATe]?
[SUITe:][UNIT#:]CHAN#:RFOUTput {OFF|ON}
[SUITe:][UNIT#:]CHAN#:RFOUTput?
[SUITe:][UNIT#:]CONFiguration
{SINGle|DUAL|RXDiversity|TXDiversity|MIMO|MIMO4x4}
```

```
[SUITe:][UNIT#:]CONF?
[SUITe:][UNIT#:][EMULation:]PAUSe
[SUITe:][UNIT#:][EMULation:]PLAY
[SUITe:][UNIT#:][EMULation:]STOP
[SUITe:][UNIT#:][EMULation:]STATe?
[SUITe:][UNIT#:]MIMO:PHSHift <Sink Index><Source Index>,<real>
[SUITe:][UNIT#:]MIMO:PHSHift <Sink Index><Source Index>?
[SUITe:][UNIT#:]MIMO:RELPower <Sink Index><Source Index>,<real>
[SUITe:][UNIT#:]MIMO:RELPower <Sink Index><Source Index>?
[SUITe:][UNIT#:]MIMO:STATe <Sink Index><Source Index>{OFF|ON}
[SUITe:][UNIT#:]MIMO:STATe <Sink Index><Source Index>?
[SUITe:][UNIT#:]NUMCHannels?
[SUITe:][UNIT#:]RELPower <real>
[SUITe:][UNIT#:]RELPower?
[SUITe:][UNIT#:]ROSCillator?
[SUITe:][UNIT#:]GCM:BSAConfig {CROSs|VERTical}
[SUITe:][UNIT#:]GCM:BSAConfig?[SUITe:][UNIT#:]GCM:BSASpacing <real>
[SUITe:][UNIT#:]GCM:BSASpacing?
[SUITe:][UNIT#:]GCM:DIRection <UL|DL>
[SUITe:][UNIT#:]GCM:DIRection?[SUITe:][UNIT#:]GCM:MSAConfig
{CROSs|VERTical}
[SUITe:][UNIT#:]GCM:MSAConfig?
[SUITe:][UNIT#:]GCM:MSASpacing <real>
[SUITe:][UNIT#:]GCM:MSASpacing?
[SUITe:][UNIT#:]GCM:XPD <real>
[SUITe:][UNIT#:]GCM:XPD?
[SUITe:][UNIT#:]GCM:PATH#:AOA <real>
[SUITe:][UNIT#:]GCM:PATH#:AOA?
[SUITe:][UNIT#:]GCM:PATH#:AOD <real>
[SUITe:][UNIT#:]GCM:PATH#:AOD?
[SUITe:][UNIT#:]GCM:PATH#:BSAS <real>
[SUITe:][UNIT#:]GCM:PATH#:BSAS?
[SUITe:][UNIT#:]GCM:PATH#:BSPAS {LAPLacian|GAUSsian|UNIForm}
[SUITe:][UNIT#:]GCM:PATH#:BSPAS?
[SUITe:][UNIT#:]GCM:PATH#:DELay:MODE?
[SUITe:][UNIT#:]GCM:PATH#:DELay[:VALue] <real>
[SUITe:][UNIT#:]GCM:PATH#:DELay?
[SUITe:][UNIT#:]GCM:PATH#:LOS[:STATe] {OFF|ON}
[SUITe:][UNIT#:]GCM:PATH#:LOS?
[SUITe:][UNIT#:]GCM:PATH#:LOS:AOA <real>
[SUITe:][UNIT#:]GCM:PATH#:LOS:AOA?
[SUITe:][UNIT#:]GCM:PATH#:LOS:AOD <real>
[SUITe:][UNIT#:]GCM:PATH#:LOS:AOD?
```

```
[SUITe:][UNIT#:]GCM:PATH#:LOS:DOPPler?
[SUITe:][UNIT#:]GCM:PATH#:LOS:KFACtor <real>
[SUITe:][UNIT#:]GCM:PATH#:LOS:KFACtor?
[SUITe:][UNIT#:]GCM:PATH#:MIDPath#:EXCDelay <real>
[SUITe:][UNIT#:]GCM:PATH#:MIDPath#:EXCDelay?
[SUITe:][UNIT#:]GCM:PATH#:MIDPath#:NUMScatterers?
[SUITe:][UNIT#:]GCM:PATH#:MIDPath#:RELPower?
[SUITe:][UNIT#:]GCM:PATH#:MIDPATHS[:STATe] {OFF|ON}
[SUITe:][UNIT#:]GCM:PATH#:MIDPATHS[:STATe]?
[SUITe:][UNIT#:]GCM:PATH#:MODulation {NONE|RAYLeigh}
[SUITe:][UNIT#:]GCM:PATH#:MODulation?
[SUITe:][UNIT#:]GCM:PATH#:MSAS <real>
[SUITe:][UNIT#:]GCM:PATH#:MSAS?
[SUITe:][UNIT#:]GCM:PATH#:MSDirection <real>
[SUITe:][UNIT#:]GCM:PATH#:MSDirection?
[SUITe:][UNIT#:]GCM:PATH#:MSPAS {LAPLacian|GAUSsian|UNIForm}
[SUITe:][UNIT#:]GCM:PATH#:MSPAS?
[SUITe:][UNIT#:]GCM:PATH#:MSVelocity <real>
[SUITe:][UNIT#:]GCM:PATH#:MSVelocity?
[SUITe:][UNIT#:]GCM:PATH#:NUMMidpaths?
[SUITe:][UNIT#:]GCM:PATH#:NUMScatterers?
[SUITe:][UNIT#:]GCM:PATH#:RPLoss <real>
[SUITe:][UNIT#:]GCM:PATH#:RPLoss?
```

6.3. Command Descriptions

NOTE: In 4x4 MIMO mode, the channel and path parameters can be accessed as CH(1-2) for both the units in 4x4 MIMO mode or CH(1-4) for the main unit (Units 1 or 3). For example, if Units 1 and 2 are in 4x4 MIMO mode, RF3 can be accessed as UNIT1:CH3 or UNIT2:CH1

`*IDN?`

Query the RPI software identification.

`*OPC?`

Query the Operation Complete bit.

`*OPT?`

Query the RPI Options string. The length of the response depends on the number of units in the suite. For a suite with multiple units, the option strings for all the units are returned beginning from Unit 1. The response string for a single unit is shown in Figure 6-1.

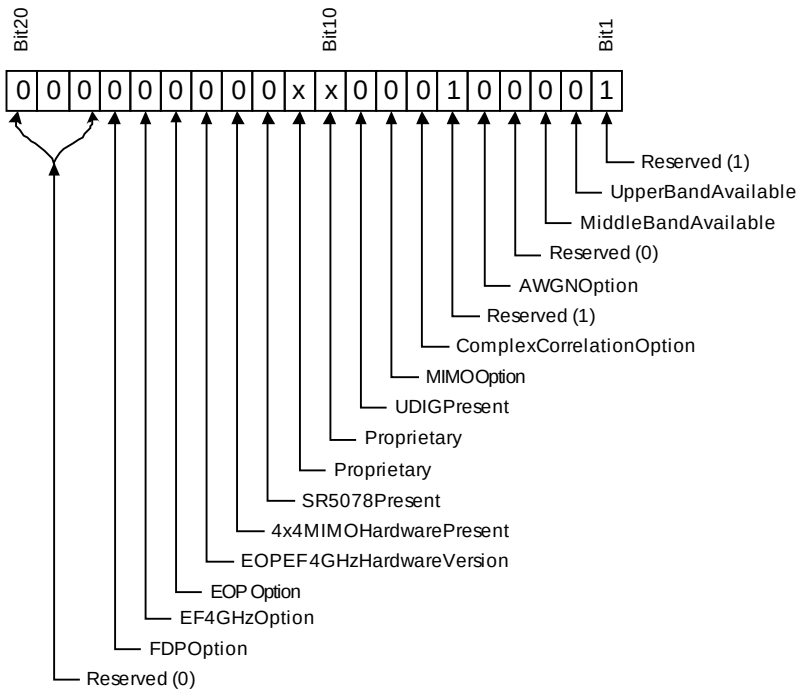


*Figure 6-1: *OPT? Response String for a Single Unit*

*RST
Reset all RPI parameters to their default settings.

[SUITe:] Subsystem

The [SUITe:] commands are used to control the overall system function.

BAND <string>
BAND?

Selects the RF Frequency Mode of the system.

Parameter	Range/Selection	*RST	Resolution
‹string›	LOWer, MIDdle, UPper	LOWer	—

Lower Band: 400-2700MHz
Middle Band: 3300-3850MHz
Upper Band: 4100-6000MHz

Middle and Upper Band are not supported when a unit in a suite is in 4x4 MIMO mode.

CORRelation:MATRix[:ALLpaths] <real list>
CORRelation:MATRix[:ALLpaths]?

Sets the channel correlation parameters for all paths in the system. This command should be used only after the CORRElation:TYPe is set to SUITe and the CORRelation:MODe is set to ENVelope, COMPonent or COMPLex.

This command is not supported for a suite with units in 2x2 or 4x4 MIMO mode.

If CORRelation:MODe is set to ENVelope or COMPonent the parameters are defined in the following tables.

Parameter	Range/Selection	*RST	Resolution
‹real list›	2 UNITS (Dual) - R0, R1, R2, … , R5 3 UNITS (Dual) - R0, R1, R2, … , R14 4 UNITS (Dual) - R0, R1, R2, … , R27 2 UNITS (Single) - R0 3 UNITS (Single) - R0, R1, R2 4 UNITS (Single) - R0, R1, R2, … , R5 (0 to 1)	0.00	0.01

2 UNITS (Dual Channel)

Index	Parameter
R0	U1C1_U1C2
R1	U1C1_U2C1
R2	U1C2_U2C1
R3	U1C1_U2C2
R4	U1C2_U2C2
R5	U2C1_U2C2

3 UNITS (Dual Channel)

Index	Parameter	Index	Parameter
R0	U1C1_U1C2	R8	U2C1_U3C1
R1	U1C1_U2C1	R9	U2C2_U3C1
R2	U1C2_U2C1	R10	U1C1_U3C2
R3	U1C1_U2C2	R11	U1C2_U3C2
R4	U1C2_U2C2	R12	U2C1_U3C2
R5	U2C1_U2C2	R13	U2C2_U3C2
R6	U1C1_U3C1	R14	U3C1_U3C2
R7	U1C2_U3C1		

4 UNITS (Dual Channel)

Index	Parameter	Index	Parameter	Index	Parameter
R0	U1C1_U1C2	R10	U1C1_U3C2	R20	U3C2_U4C1
R1	U1C1_U2C1	R11	U1C2_U3C2	R21	U1C1_U4C2
R2	U1C2_U2C1	R12	U2C1_U3C2	R22	U1C2_U4C2
R3	U1C1_U2C2	R13	U2C2_U3C2	R23	U2C1_U4C2
R4	U1C2_U2C2	R14	U3C1_U3C2	R24	U2C2_U4C2
R5	U2C1_U2C2	R15	U1C1_U4C1	R25	U3C1_U4C2
R6	U1C1_U3C1	R16	U1C2_U4C1	R26	U3C2_U4C2
R7	U1C2_U3C1	R17	U2C1_U4C1	R27	U4C1_U4C2
R8	U2C1_U3C1	R18	U2C2_U4C1		
R9	U2C2_U3C1	R19	U3C1_U4C1		

2 UNITS (Single Channel)

Index	Parameter
R0	U1C1_U2C1

3 UNITS (Single Channel)

Index	Parameter
R0	U1C1_U2C1
R1	U1C1_U3C1
R2	U2C1_U3C1

4 UNITS (Single Channel)

Index	Parameter
R0	U1C1_U2C1
R1	U1C1_U3C1
R2	U2C1_U3C1
R3	U1C1_U4C1
R4	U2C1_U4C1
R5	U3C1_U4C1

CORRelation:MATRix:PATH# <real list>

CORRelation:MATRix:PATH#?

Sets the channel correlation parameters for a given path in the system. This command should be used only after the CORRElation:TYPe is set to SUITe and CORRelation:MODe is set to COMPLex.

This command is not supported for a suite with 2 units in 4x4 MIMO mode.

The parameters are defined in the following tables.

Parameter	Range/Selection	*RST	Resolution
#	1 to 24 (path)	1	1
‹real list›	2 UNITS (Dual) - R0, R1, R2, … , R11 3 UNITS (Dual) - R0, R1, R2, … , R29 4 UNITS (Dual) - R0, R1, R2, … , R55 2 UNITS (Single) - R0, R1 3 UNITS (Single) - R0, R1, R2, … , R5 4 UNITS (Single) - R0, R1, R2, … , R11 2 UNITS (MIMO) - R0, R1, R2, … , R55 3 UNITS (MIMO) - R0, R1, R2, … , R131 4 UNITS (MIMO) - R0, R1, R2, … , R239 (-1 to 1)	0.00	0.0001

2 UNITS (Dual Channel, Complex Correlation)

Index	Parameter	Index	Parameter
R0	U1C1_U1C2_Real	R6	U1C1_U2C2_Real
R1	U1C1_U1C2_Imag	R7	U1C1_U2C2_Imag
R2	U1C1_U2C1_Real	R8	U1C2_U2C2_Real
R3	U1C1_U2C1_Imag	R9	U1C2_U2C2_Imag
R4	U1C2_U2C1_Real	R10	U2C1_U2C2_Real
R5	U1C2_U2C1_Imag	R11	U2C1_U2C2_Imag

3 UNITS (Dual Channel, Complex Correlation)

Index	Parameter	Index	Parameter	Index	Parameter
R0	U1C1_U1C2_Real	R10	U2C1_U2C2_Real	R20	U1C1_U3C2_Real
R1	U1C1_U1C2_Imag	R11	U2C1_U2C2_Imag	R21	U1C1_U3C2_Imag
R2	U1C1_U2C1_Real	R12	U1C1_U3C1_Real	R22	U1C2_U3C2_Real
R3	U1C1_U2C1_Imag	R13	U1C1_U3C1_Imag	R23	U1C2_U3C2_Imag
R4	U1C2_U2C1_Real	R14	U1C2_U3C1_Real	R24	U2C1_U3C2_Real
R5	U1C2_U2C1_Imag	R15	U1C2_U3C1_Imag	R25	U2C1_U3C2_Imag
R6	U1C1_U2C2_Real	R16	U2C1_U3C1_Real	R26	U2C2_U3C2_Real
R7	U1C1_U2C2_Imag	R17	U2C1_U3C1_Imag	R27	U2C2_U3C2_Imag
R8	U1C2_U2C2_Real	R18	U2C2_U3C1_Real	R28	U3C1_U3C2_Real
R9	U1C2_U2C2_Imag	R19	U2C2_U3C1_Imag	R29	U3C1_U3C2_Imag

4 UNITS (Dual Channel, Complex Correlation)

Index	Parameter	Index	Parameter	Index	Parameter
R0	U1C1_U1C2_Real	R19	U2C2_U3C1_Imag	R38	U3C1_U4C1_Real
R1	U1C1_U1C2_Imag	R20	U1C1_U3C2_Real	R39	U3C1_U4C1_Imag
R2	U1C1_U2C1_Real	R21	U1C1_U3C2_Imag	R40	U3C2_U4C1_Real
R3	U1C1_U2C1_Imag	R22	U1C2_U3C2_Real	R41	U3C2_U4C1_Imag
R4	U1C2_U2C1_Real	R23	U1C2_U3C2_Imag	R42	U1C1_U4C2_Real
R5	U1C2_U2C1_Imag	R24	U2C1_U3C2_Real	R43	U1C1_U4C2_Imag
R6	U1C1_U2C2_Real	R25	U2C1_U3C2_Imag	R44	U1C2_U4C2_Real
R7	U1C1_U2C2_Imag	R26	U2C2_U3C2_Real	R45	U1C2_U4C2_Imag
R8	U1C2_U2C2_Real	R27	U2C2_U3C2_Imag	R46	U2C1_U4C2_Real
R9	U1C2_U2C2_Imag	R28	U3C1_U3C2_Real	R47	U2C1_U4C2_Imag
R10	U2C1_U2C2_Real	R29	U3C1_U3C2_Imag	R48	U2C2_U4C2_Real
R11	U2C1_U2C2_Imag	R30	U1C1_U4C1_Real	R49	U2C2_U4C2_Imag
R12	U1C1_U3C1_Real	R31	U1C1_U4C1_Imag	R50	U3C1_U4C2_Real
R13	U1C1_U3C1_Imag	R32	U1C2_U4C1_Real	R51	U3C1_U4C2_Imag
R14	U1C2_U3C1_Real	R33	U1C2_U4C1_Imag	R52	U3C2_U4C2_Real

Index	Parameter	Index	Parameter	Index	Parameter
R15	U1C2_U3C1_Imag	R34	U2C1_U4C1_Real	R53	U3C2_U4C2_Imag
R16	U2C1_U3C1_Real	R35	U2C1_U4C1_Imag	R54	U4C1_U4C2_Real
R17	U2C1_U3C1_Imag	R36	U2C2_U4C1_Real	R55	U4C1_U4C2_Imag
R18	U2C2_U3C1_Real	R37	U2C2_U4C1_Imag		

2 UNITS (Single Channel, Complex Correlation)

Index	Parameter
R0	U1C1_U2C1_Real
R1	U1C1_U2C1_Imag

3 UNITS (Single Channel, Complex Correlation)

Index	Parameter
R0	U1C1_U2C1_Real
R1	U1C1_U2C1_Imag
R2	U1C1_U3C1_Real
R3	U1C1_U3C1_Imag
R4	U2C1_U3C1_Real
R5	U2C1_U3C1_Imag

4 UNITS (Single Channel, Complex Correlation)

Index	Parameter	Index	Parameter
R0	U1C1_U2C1_Real	R6	U1C1_U4C1_Real
R1	U1C1_U2C1_Imag	R7	U1C1_U4C1_Imag
R2	U1C1_U3C1_Real	R8	U2C1_U4C1_Real
R3	U1C1_U3C1_Imag	R9	U2C1_U4C1_Imag
R4	U2C1_U3C1_Real	R10	U3C1_U4C1_Real
R5	U2C1_U3C1_Imag	R11	U3C1_U4C1_Imag

2 UNITS (2x2 MIMO, Complex Correlation)

Index	Parameter	Index	Parameter	Index	Parameter
R0	U1h21_U1h11_Real	R20	U2h21_U1h11_Real	R40	U2h12_U2h21_Real
R1	U1h21_U1h11_Imag	R21	U2h21_U1h11_Imag	R41	U2h12_U2h21_Imag
R2	U1h12_U1h11_Real	R22	U2h21_U1h21_Real	R42	U2h22_U1h11_Real
R3	U1h12_U1h11_Imag	R23	U2h21_U1h21_Imag	R43	U2h22_U1h11_Imag
R4	U1h12_U1h21_Real	R24	U2h21_U1h12_Real	R44	U2h22_U1h21_Real
R5	U1h12_U1h21_Imag	R25	U2h21_U1h12_Imag	R45	U2h22_U1h21_Imag
R6	U1h22_U1h11_Real	R26	U2h21_U1h22_Real	R46	U2h22_U1h12_Real
R7	U1h22_U1h11_Imag	R27	U2h21_U1h22_Imag	R47	U2h22_U1h12_Imag

Index	Parameter	Index	Parameter	Index	Parameter
R8	U1h22_U1h21_Real	R28	U2h21_U2h11_Real	R48	U2h22_U1h22_Real
R9	U1h22_U1h21_Imag	R29	U2h21_U2h11_Imag	R49	U2h22_U1h22_Imag
R10	U1h22_U1h12_Real	R30	U2h12_U1h11_Real	R50	U2h22_U2h11_Real
R11	U1h22_U1h12_Imag	R31	U2h12_U1h11_Imag	R51	U2h22_U2h11_Imag
R12	U2h11_U1h11_Real	R32	U2h12_U1h21_Real	R52	U2h22_U2h21_Real
R13	U2h11_U1h11_Imag	R33	U2h12_U1h21_Imag	R53	U2h22_U2h21_Imag
R14	U2h11_U1h21_Real	R34	U2h12_U1h12_Real	R54	U2h22_U2h12_Real
R15	U2h11_U1h21_Imag	R35	U2h12_U1h12_Imag	R55	U2h22_U2h12_Imag
R16	U2h11_U1h12_Real	R36	U2h12_U1h22_Real		
R17	U2h11_U1h12_Imag	R37	U2h12_U1h22_Imag		
R18	U2h11_U1h22_Real	R38	U2h12_U2h11_Real		
R19	U2h11_U1h22_Imag	R39	U2h12_U2h11_Imag		

3 UNITS (2x2 MIMO, Complex Correlation) (R0..R55 as above)

Index	Parameter	Index	Parameter	Index	Parameter
R56	U3h11_U1h11_Real	R78	U3h21_U1h22_Real	R100	U3h12_U2h21_Real
R57	U3h11_U1h11_Imag	R79	U3h21_U1h22_Imag	R101	U3h12_U2h21_Imag
R58	U3h11_U1h21_Real	R86	U3h21_U2h22_Real	R112	U3h22_U1h21_Real
R59	U3h11_U1h21_Imag	R87	U3h21_U2h22_Imag	R113	U3h22_U1h21_Imag
R60	U3h11_U1h12_Real	R88	U3h21_U3h11_Real	R114	U3h22_U1h12_Real
R61	U3h11_U1h12_Imag	R89	U3h21_U3h11_Imag	R115	U3h22_U1h12_Imag
R62	U3h11_U1h22_Real	R90	U3h12_U1h11_Real	R116	U3h22_U1h22_Real
R63	U3h11_U1h22_Imag	R91	U3h12_U1h11_Imag	R117	U3h22_U1h22_Imag
R64	U3h11_U2h11_Real	R92	U3h12_U1h21_Real	R118	U3h22_U2h11_Real
R65	U3h11_U2h11_Imag	R93	U3h12_U1h21_Imag	R119	U3h22_U2h11_Imag
R66	U3h11_U2h21_Real	R94	U3h12_U1h12_Real	R120	U3h22_U2h21_Real
R67	U3h11_U2h21_Imag	R95	U3h12_U1h12_Imag	R121	U3h22_U2h21_Imag
R68	U3h11_U2h12_Real	R96	U3h12_U1h22_Real	R122	U3h22_U2h12_Real
R69	U3h11_U2h12_Imag	R97	U3h12_U1h22_Imag	R123	U3h22_U2h12_Imag
R70	U3h11_U2h22_Real	R98	U3h12_U2h11_Real	R124	U3h22_U2h22_Real
R71	U3h11_U2h22_Imag	R99	U3h12_U2h11_Imag	R125	U3h22_U2h22_Imag
R72	U3h21_U1h11_Real	R100	U3h12_U2h21_Real	R126	U3h22_U3h11_Real
R73	U3h21_U1h11_Imag	R101	U3h12_U2h21_Imag	R127	U3h22_U3h11_Imag
R74	U3h21_U1h21_Real	R102	U3h12_U2h12_Real	R128	U3h22_U3h21_Real
R75	U3h21_U1h21_Imag	R103	U3h12_U2h12_Imag	R129	U3h22_U3h21_Imag
R76	U3h21_U1h12_Real	R104	U3h12_U2h22_Real	R130	U3h22_U3h12_Real
R77	U3h21_U1h12_Imag	R105	U3h12_U2h22_Imag	R131	U3h22_U3h12_Imag

Index	Parameter	Index	Parameter	Index	Parameter
R80	U3h21_U2h11_Real	R106	U3h12_U3h11_Real		
R81	U3h21_U2h11_Imag	R107	U3h12_U3h11_Imag		
R82	U3h21_U2h21_Real	R108	U3h12_U3h21_Real		
R83	U3h21_U2h21_Imag	R109	U3h12_U3h21_Imag		
R84	U3h21_U2h12_Real	R110	U3h22_U1h11_Real		
R85	U3h21_U2h12_Imag	R111	U3h22_U1h11_Imag		

4 UNITS (2x2 MIMO, Complex Correlation) (R0..R131 as above)

Index	Parameter	Index	Parameter	Index	Parameter
R132	U4h11_U1h11_Real	R168	U4h21_U2h12_Real	R204	U4h12_U3h22_Real
R133	U4h11_U1h11_Imag	R169	U4h21_U2h12_Imag	R205	U4h12_U3h22_Imag
R134	U4h11_U1h21_Real	R170	U4h21_U2h22_Real	R206	U4h12_U4h11_Real
R135	U4h11_U1h21_Imag	R171	U4h21_U2h22_Imag	R207	U4h12_U4h11_Imag
R136	U4h11_U1h12_Real	R172	U4h21_U3h11_Real	R208	U4h12_U4h21_Real
R137	U4h11_U1h12_Imag	R173	U4h21_U3h11_Imag	R209	U4h12_U4h21_Imag
R138	U4h11_U1h22_Real	R174	U4h21_U3h21_Real	R210	U4h22_U1h11_Real
R139	U4h11_U1h22_Imag	R175	U4h21_U3h21_Imag	R211	U4h22_U1h11_Imag
R140	U4h11_U2h11_Real	R176	U4h21_U3h12_Real	R212	U4h22_U1h21_Real
R141	U4h11_U2h11_Imag	R177	U4h21_U3h12_Imag	R213	U4h22_U1h21_Imag
R142	U4h11_U2h21_Real	R178	U4h21_U3h22_Real	R214	U4h22_U1h12_Real
R143	U4h11_U2h21_Imag	R179	U4h21_U3h22_Imag	R215	U4h22_U1h12_Imag
R144	U4h11_U2h12_Real	R180	U4h21_U4h11_Real	R216	U4h22_U1h22_Real
R145	U4h11_U2h12_Imag	R181	U4h21_U4h11_Imag	R217	U4h22_U1h22_Imag
R146	U4h11_U2h22_Real	R182	U4h12_U1h11_Real	R218	U4h22_U2h11_Real
R147	U4h11_U2h22_Imag	R183	U4h12_U1h11_Imag	R219	U4h22_U2h11_Imag
R148	U4h11_U3h11_Real	R184	U4h12_U1h21_Real	R220	U4h22_U2h21_Real
R149	U4h11_U3h11_Imag	R185	U4h12_U1h21_Imag	R221	U4h22_U2h21_Imag
R150	U4h11_U3h21_Real	R186	U4h12_U1h12_Real	R222	U4h22_U2h12_Real
R151	U4h11_U3h21_Imag	R187	U4h12_U1h12_Imag	R223	U4h22_U2h12_Imag
R152	U4h11_U3h12_Real	R188	U4h12_U1h22_Real	R224	U4h22_U2h22_Real
R153	U4h11_U3h12_Imag	R189	U4h12_U1h22_Imag	R225	U4h22_U2h22_Imag
R154	U4h11_U3h22_Real	R190	U4h12_U2h11_Real	R226	U4h22_U3h11_Real
R155	U4h11_U3h22_Imag	R191	U4h12_U2h11_Imag	R227	U4h22_U3h11_Imag
R156	U4h21_U1h11_Real	R192	U4h12_U2h21_Real	R228	U4h22_U3h21_Real
R157	U4h21_U1h11_Imag	R193	U4h12_U2h21_Imag	R229	U4h22_U3h21_Imag
R158	U4h21_U1h21_Real	R194	U4h12_U2h12_Real	R230	U4h22_U3h12_Real
R159	U4h21_U1h21_Imag	R195	U4h12_U2h12_Imag	R231	U4h22_U3h12_Imag

Index	Parameter	Index	Parameter	Index	Parameter
R160	U4h21_U1h12_Real	R196	U4h12_U2h22_Real	R232	U4h22_U3h22_Real
R161	U4h21_U1h12_Imag	R197	U4h12_U2h22_Imag	R233	U4h22_U3h22_Imag
R162	U4h21_U1h22_Real	R198	U4h12_U3h11_Real	R234	U4h22_U4h11_Real
R163	U4h21_U1h22_Imag	R199	U4h12_U3h11_Imag	R235	U4h22_U4h11_Imag
R164	U4h21_U2h11_Real	R200	U4h12_U3h21_Real	R236	U4h22_U4h21_Real
R165	U4h21_U2h11_Imag	R201	U4h12_U3h21_Imag	R237	U4h22_U4h21_Imag
R166	U4h21_U2h21_Real	R202	U4h12_U3h12_Real	R238	U4h22_U4h12_Real
R167	U4h21_U2h21_Imag	R203	U4h12_U3h12_Imag	R239	U4h22_U4h12_Imag

CORRelation:MODe <string>
CORRelation:MODe?

Set the Correlation Coefficient Mode of the system.

Parameter	Range/Selection	*RST	Resolution
‹string›	ENVelope, COMPonent, COMPLex	ENVelope	—

CORRelation:TYPe <string>
CORRelation:TYPe?

Set the Correlation Type for the system.

Parameter	Range/Selection	*RST	Resolution
‹string›	INSTrument, SUITe	INSTrument	—

CORRelation[:UNIT#]:AWGNCorrelation <bool>
CORRelation[:UNIT#]:AWGNCorrelation?

Disable or enable AWGN correlation for the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4	1	1
‹bool›	OFF, ON	OFF	—

CORRelation[:UNIT#]:AWGNValid?

Query whether the current setup of the given unit is valid for AWGN correlation.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4	1	1

CORRelation[:UNIT#]:CHCorrelation <real list>
CORRelation[:UNIT#]:CHCorrelation?

Set the Channel Correlation for a given unit. This command should be used only after the CORRElation:TYPe is set to INSTrument. If CORRelation[UNIT#:]IMODe is set to COMPLex the correlation would be set to R1 + R2j. Otherwise, the correlation will be set to R1.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4	1	1
‹real list›	R1, R2 0 to 1	0.00	0.01

CORRelation[:UNIT#]:CHCValid?

Query whether the current setup of the given unit is valid for channel correlation.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4	1	1

CORRelation[:UNIT#]:IMATRix:PATH# <real list>

CORRelation[:UNIT#]:IMATRix:PATH#?

Set the Channel Correlation Parameters for a given path in the system. This command is supported only for units in 2x2 MIMO or 4x4 MIMO mode when the correlation is Instrument-Based and not System-Based. This is supported only for Unit 1 (3) in 4x4 MIMO mode, and not for Unit 2 (4).

Parameter	Range/Selection	*RST	Resolution
#	1 to 24*	1	1
‹real list›	R0, R1, R2, … , R11 (-1 to 1)	0.00	0.0001

2x2 MIMO Mode

Index	Parameter	Index	Parameter
R0	U1h21_U1h11_Real	R6	U1h22_U1h11_Real
R1	U1h21_U1h11_Imag	R7	U1h22_U1h11_Imag
R2	U1h12_U1h11_Real	R8	U1h22_U1h21_Real
R3	U1h12_U1h11_Imag	R9	U1h22_U1h21_Imag
R4	U1h12_U1h21_Real	R10	U1h22_U1h12_Real
R5	U1h12_U1h21_Imag	R11	U1h22_U1h12_Imag

4x4 MIMO Mode

Index	Parameter	Index	Parameter	Index	Parameter
R0	h21_h11_Real	R80	h23_h12_Real	R160	h24_h31_Real
R1	h21_h11_Imag	R81	h23_h12_Imag	R161	h24_h31_Imag
R2	h31_h11_Real	R82	h23_h22_Real	R162	h24_h41_Real
R3	h31_h11_Imag	R83	h23_h22_Imag	R163	h24_h41_Imag
R4	h31_h21_Real	R84	h23_h32_Real	R164	h24_h12_Real
R5	h31_h21_Imag	R85	h23_h32_Imag	R165	h24_h12_Imag
R6	h41_h11_Real	R86	h23_h42_Real	R166	h24_h22_Real
R7	h41_h11_Imag	R87	h23_h42_Imag	R167	h24_h22_Imag

Index	Parameter	Index	Parameter	Index	Parameter
R8	h41_h21_Real	R88	h23_h13_Real	R168	h24_h32_Real
R9	h41_h21_Imag	R89	h23_h13_Imag	R169	h24_h32_Imag
R10	h41_h31_Real	R90	h33_h11_Real	R170	h24_h42_Real
R11	h41_h31_Imag	R91	h33_h11_Imag	R171	h24_h42_Imag
R12	h12_h11_Real	R92	h33_h21_Real	R172	h24_h13_Real
R13	h12_h11_Imag	R93	h33_h21_Imag	R173	h24_h13_Imag
R14	h12_h21_Real	R94	h33_h31_Real	R174	h24_h23_Real
R15	h12_h21_Imag	R95	h33_h31_Imag	R175	h24_h23_Imag
R16	h12_h31_Real	R96	h33_h41_Real	R176	h24_h33_Real
R17	h12_h31_Imag	R97	h33_h41_Imag	R177	h24_h33_Imag
R18	h12_h41_Real	R98	h33_h12_Real	R178	h24_h43_Real
R19	h12_h41_Imag	R99	h33_h12_Imag	R179	h24_h43_Imag
R20	h22_h11_Real	R100	h33_h22_Real	R180	h24_h14_Real
R21	h22_h11_Imag	R101	h33_h22_Imag	R181	h24_h14_Imag
R22	h22_h21_Real	R102	h33_h32_Real	R182	h34_h11_Real
R23	h22_h21_Imag	R103	h33_h32_Imag	R183	h34_h11_Imag
R24	h22_h31_Real	R104	h33_h42_Real	R184	h34_h21_Real
R25	h22_h31_Imag	R105	h33_h42_Imag	R185	h34_h21_Imag
R26	h22_h41_Real	R106	h33_h13_Real	R186	h34_h31_Real
R27	h22_h41_Imag	R107	h33_h13_Imag	R187	h34_h31_Imag
R28	h22_h12_Real	R108	h33_h23_Real	R188	h34_h41_Real
R29	h22_h12_Imag	R109	h33_h23_Imag	R189	h34_h41_Imag
R30	h32_h11_Real	R110	h43_h11_Real	R190	h34_h12_Real
R31	h32_h11_Imag	R111	h43_h11_Imag	R191	h34_h12_Imag
R32	h32_h21_Real	R112	h43_h21_Real	R192	h34_h22_Real
R33	h32_h21_Imag	R113	h43_h21_Imag	R193	h34_h22_Imag
R34	h32_h31_Real	R114	h43_h31_Real	R194	h34_h32_Real
R35	h32_h31_Imag	R115	h43_h31_Imag	R195	h34_h32_Imag
R36	h32_h41_Real	R116	h43_h41_Real	R196	h34_h42_Real
R37	h32_h41_Imag	R117	h43_h41_Imag	R197	h34_h42_Imag
R38	h32_h12_Real	R118	h43_h12_Real	R198	h34_h13_Real
R39	h32_h12_Imag	R119	h43_h12_Imag	R199	h34_h13_Imag
R40	h32_h22_Real	R120	h43_h22_Real	R200	h34_h23_Real
R41	h32_h22_Imag	R121	h43_h22_Imag	R201	h34_h23_Imag
R42	h42_h11_Real	R122	h43_h32_Real	R202	h34_h33_Real
R43	h42_h11_Imag	R123	h43_h32_Imag	R203	h34_h33_Imag
R44	h42_h21_Real	R124	h43_h42_Real	R204	h34_h43_Real
R45	h42_h21_Imag	R125	h43_h42_Imag	R205	h34_h43_Imag

Index	Parameter	Index	Parameter	Index	Parameter
R46	h42_h31_Real	R126	h43_h13_Real	R206	h34_h14_Real
R47	h42_h31_Imag	R127	h43_h13_Imag	R207	h34_h14_Imag
R48	h42_h41_Real	R128	h43_h23_Real	R208	h34_h24_Imag
R49	h42_h41_Imag	R129	h43_h23_Imag	R209	h34_h24_Real
R50	h42_h12_Real	R130	h43_h33_Real	R210	h44_h11_Real
R51	h42_h12_Imag	R131	h43_h33_Imag	R211	h44_h11_Imag
R52	h42_h22_Real	R132	h14_h11_Real	R212	h44_h21_Real
R53	h42_h22_Imag	R133	h14_h11_Imag	R213	h44_h21_Imag
R54	h42_h32_Real	R134	h14_h21_Real	R214	h44_h31_Real
R55	h42_h32_Imag	R135	h14_h21_Imag	R215	h44_h31_Imag
R56	h13_h11_Real	R136	h14_h31_Real	R216	h44_h41_Real
R57	h13_h11_Imag	R137	h14_h31_Imag	R217	h44_h41_Imag
R58	h13_h21_Real	R138	h14_h41_Real	R218	h44_h12_Real
R59	h13_h21_Imag	R139	h14_h41_Imag	R219	h44_h12_Imag
R60	h13_h31_Real	R140	h14_h12_Real	R220	h44_h22_Real
R61	h13_h31_Imag	R141	h14_h12_Imag	R221	h44_h22_Imag
R62	h13_h41_Real	R142	h14_h22_Real	R222	h44_h32_Real
R63	h13_h41_Imag	R143	h14_h22_Imag	R223	h44_h32_Imag
R64	h13_h12_Real	R144	h14_h32_Real	R224	h44_h42_Real
R65	h13_h12_Imag	R145	h14_h32_Imag	R225	h44_h42_Imag
R66	h13_h22_Real	R146	h14_h42_Real	R226	h44_h13_Real
R67	h13_h22_Imag	R147	h14_h42_Imag	R227	h44_h13_Imag
R68	h13_h32_Real	R148	h14_h13_Real	R228	h44_h23_Real
R69	h13_h32_Imag	R149	h14_h13_Imag	R229	h44_h23_Imag
R70	h13_h42_Real	R150	h14_h23_Real	R230	h44_h33_Real
R71	h13_h42_Imag	R151	h14_h23_Imag	R231	h44_h33_Imag
R72	h23_h11_Real	R152	h14_h33_Real	R232	h44_h43_Real
R73	h23_h11_Imag	R153	h14_h33_Imag	R233	h44_h43_Imag
R74	h23_h21_Real	R154	h14_h43_Real	R234	h44_h14_Real
R75	h23_h21_Imag	R155	h14_h43_Imag	R235	h44_h14_Imag
R76	h23_h31_Real	R156	h24_h11_Real	R236	h44_h24_Imag
R77	h23_h31_Imag	R157	h24_h11_Imag	R237	h44_h24_Real
R78	h23_h41_Real	R158	h24_h21_Real	R238	h44_h34_Real
R79	h23_h41_Imag	R159	h24_h21_Imag	R239	h44_h34_Imag

CORRelation[:UNIT#]:IMODe <string>

CORRelation[:UNIT#]:IMODe?

Set the Correlation Coefficient Mode of the given unit. Only COMPLex correlation is supported in MIMO (2x2, 4x4) mode.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4	1	1
‹string›	ENVelope, COMPonent, COMPLex	ENVelope	—

DEE:CLOOP?

Query the current DEE loop number.

DEE:COMPile:ABORt

Abort the DEE compile.

DEE:COMPile:BEGin

Begin a DEE compile.

DEE:COMPile:FILE# <string>

Sets the DEE emulation file for the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
‹string›	“valid path\filename”	“”	—

DEE:COMPile:FILE#?

Returns the DEE emulation file for the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1

DEE:COMPile:STATus?

Query the DEE compile status.

Possible Responses:

```
"Aborting"
– Abort command received, but not finished processing.
"Aborted"
– Compile was aborted
"Completed"
– Compile completed successfully
"Failed"
– Compile Failed
"Compiling"
- Compile in process, reported during initial compile, before
individual unit compile beginsd
“Compiling Unit X , Y% Complete"
- Compile in progress, specifies unit and % complete
"Compiling Unit X: Complete"
```

- Compile in progress, reported when one unit is complete, but the next not yet begun.

DEE:CSTate?

Query the current DEE state number.

DEE:ETIMe?

Query the current DEE elapsed time.

DEE:LATency <int>

DEE:LATency?

Set the DEE Network Latency for time triggered play mode.

Parameter	Range/Selection	*RST	Resolution
‹int›	0 to 65535 (ms)	—	1

DEE:MODe <string>

DEE:MODe?

Set the DEE Playback Mode to loop continuously, to loop once, or to loop a specific number of times.

Parameter	Range/Selection	*RST	Resolution
‹string›	WRAParound, ONCE, NUMber	ONCE	—

DEE:NUMberloops <int>

DEE:NUMberloops?

Set the number of loops to play DEE when DEE:MODe is set to NUMber.

Parameter	Range/Selection	*RST	Resolution
‹int›	1 to 65535	1	1

DEE:NUMSTates?

Query the number of DEE states.

DEE[:STATe] <bool>

DEE[:STATe]?

Enable or disable DEE.

Parameter	Range/Selection	*RST	Resolution
‹bool›	OFF, ON	OFF	—

DEE:TRIGtime <string>

DEE:TRIGtime?

Set the start time for DEE Time Triggered mode (e.g. “2:45:21 PM” or in 24-hour format “14:45:21”).

Parameter	Range/Selection	*RST	Resolution
‹string›	“HH:mm:ss” or “HH:mm:ss tt”	—	1 (s)

DEE:TYPe <string>

DEE:TYPe?

Set the DEE Trigger Mode to Free Play, HW Triggered, or Time Triggered.

Parameter	Range/Selection	*RST	Resolution
‹string›	FREErun, TRIGgered, TIMetriggered	FREErun	—

ERR?

Query the error queue. Refer to Section 5.4.7 on page 181 for possible responses.

FADLab:FDP:ETIMe?

Query the current Fading Data Playback elapsed time.

FADLab:FDP:STATe <bool>

Enable or disable Fading Data Playback.

Parameter	Range/Selection	*RST	Resolution
‹bool›	OFF, ON	OFF	—

FADLab:FDP[:UNIT#]:BDOWnload

Begin a Fading Data Playback download for the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1

FADLab:FDP[:UNIT#]:CLOOP?

Query the current Fading Data Playback loop number, which increments each time the data file for the given unit has played out to completion and restarted at the beginning.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1

FADLab:FDP[:UNIT#]:DABort

Abort a Fading Data Playback download for the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1

FADLab:FDP[:UNIT#]:DPRogress?

Query the current Fading Data Playback download percentage for the given unit (0 to 100).

Parameter	Range/Selection	*RST	Resolution

#	1 to 4 (unit)	1	1

FADLab:FDP[:UNIT#]:DSTatus?

Query the current Fading Data Playback download status for the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1

Possible responses:

“Aborted”

Fading Data Playback download was aborted for the given unit.

“Complete”

Fading Data Playback download was completed successfully for the given unit.

“Errored”

Fading Data Playback download for the given unit completed in error.

“InProgress”

Fading Data Playback download for the given unit is in progress.

“TimedOut”

Fading Data Playback download for the given unit was halted due to a timeout.

FADLab:FDP[:UNIT#]:FILE <string>

Sets the Fading Data Playback file for the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
‹string›	“valid path\filename”	“”	—

FADLab:FDP[:UNIT#]:FILE?

Returns the Fading Data Playback file for the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1

FADLab:FDP[:UNIT#]:REPRate?

Returns the Fading Data Playback repetition rate of the specified file for the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1

FADMode <string>

FADMode?

Set the Fading Mode for all units in the suite.

Parameter	Range/Selection	*RST	Resolution
‹string›	FNoise, SOS	FNoise	—

LOAD <string>

Load a Wireless Channel Emulator (.wce) settings file.

Parameter	Range/Selection	*RST	Resolution
‹string›	“full valid path\filename.wce”	“”	—

LOADPDP <string>

Load a Power Delay Profile from a Wireless Channel Emulator (.wce) settings file.

Parameter	Range/Selection	*RST	Resolution
‹string›	“full valid path\filename.wce”	“”	—

NUMUnits?

Query the number of SR5500 units in the suite.

SAVE <string>

Save a Wireless Channel Emulator (.wce) settings file.

Parameter	Range/Selection	*RST	Resolution
‹string›	“full valid path\filename.wce”	“”	—

SYNChronize?

Query the synchronization state of the system.

Off(0): system is unsynchronized
On(1): system is synchronized.

[UNIT#:]ASTatus?

Query the Autoset status for the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1

Possible responses:

“Failed”
Failed to Autoset.
“Aborted”
Autoset Aborted
“Complete”
Autoset completed successfully

```
   “InProgress”
Autoset in progress.
   “Averaging”
Autoset in Progress - Averaging
   “Ranging”
Autoset in Progress - Ranging
   “WaitingForTrigger”
Autoset in Progress – No triggers yet received.
```

[UNIT#:]CHAN#:AABort

Abort the Autoset for the given channel of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1

[UNIT#:]CHAN#:BAUToset

Begin an Autoset on the given channel of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1

[UNIT#:]CHAN#:BDEath:DBINs <real list>
[UNIT#:]CHAN#:BDEath:DBINs?

Set the Birth Death Delay Bins for the given channel of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹real list›	R1, R2, … , R64 0 to 2000 (us)	0	0.0001

[UNIT#:]CHAN#:BDEath:NUMBins?

Query the number of active Birth Death delay bins for the given channel of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1

[UNIT#:]CHAN#:BDEath:SDURation <real>
[UNIT#:]CHAN#:BDEath:SDURation?

Set the Birth Death state duration for the given channel of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹real›	0.001 to 60 (s)	0.001	0.001

[UNIT#:]CHAN#:BYPass <bool>
[UNIT#:]CHAN#:BYPass?

Enable or disable the Bypass mode of the given channel of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹bool›	OFF, ON	OFF	—

[UNIT#:]CHAN#:CBLLoss <real>
[UNIT#:]CHAN#:CBLLoss?

Offset the Output level of the given channel of the given unit by providing a cable loss correction.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹real›	-10 to 10 (dB)	0	0.01

[UNIT#:]CHAN#:CFACtor <real>
[UNIT#:]CHAN#:CFACtor?

Set the Crest Factor for the given channel of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹real›	15 to 35 (dB)	15	0.1

[UNIT#:]CHAN#:CLROVerload

Clear the Overload Indicator for the given channel of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1

[UNIT#:]CHAN#:FREQuency <real>
[UNIT#:]CHAN#:FREQuency?

Set the Channel Frequency.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹real›	400 to 6000 (MHz)*	900	0.001

*: Refer to the *BAND* command on page 195 for appropriate ranges.

[UNIT#:]CHAN#:INPPHAse <real>
[UNIT#:]CHAN#:INPPHAse?

Sets the RF Port Input Phase Offset

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹real›	-360.0 to 360.0	0	0.1

[UNIT#:]CHAN#:INPut <real>

[UNIT#:]CHAN#:INPut?

Set the Input Level of the given channel of the given unit. The corresponding query returns the set input level (in dBm).

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹real›	-32 to 5 (dBm)*	-10	0.01

*: The actual range will vary based on the state of other system parameters.

[UNIT#:]CHAN#:INTerferer:BITRate <real>

[UNIT#:]CHAN#:INTerferer:BITRate?

Set the Interferer Bit Rate of the given channel of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹real›	0.1 to 100000 (kbps)	9.6	0.001

[UNIT#:]CHAN#:INTerferer:CTON <real>

[UNIT#:]CHAN#:INTerferer:CTON?

Set the C/N ratio for the given channel of the given unit. The corresponding query returns the set C/N ratio (in dB).

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹real›	-30 to 32 (dB)*	0	0.1

*: The actual range will vary based on the state of other system parameters.

[UNIT#:]CHAN#:INTerferer:CTONO <real>

[UNIT#:]CHAN#:INTerferer:CTONO?

Set the C/No ratio for the given channel of the given unit. The corresponding query returns the set C/No ratio (in dB/Hz).

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹real›	35.8 to 97.8 (dB/Hz)*	65.8	0.1

*: The actual range will vary based on the state of other system parameters.

[UNIT#:]CHAN#:INTerferer:EBNO <real>

[UNIT#:]CHAN#:INTerferer:EBNO?

Set the Eb/No ratio for the given channel of the given unit. The corresponding query returns the set Eb/No ratio (in dB).

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹real›	-4 to 58 (dB)*	26	0.1

*: The actual range will vary based on the state of other system parameters.

[UNIT#:]CHAN#:INTerferer:MODe <string>

[UNIT#:]CHAN#:INTerferer:MODe?

Set the Interferer Mode for the given channel of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹string›	OFF, AWGN	OFF	—

[UNIT#:]CHAN#:INTerferer:NBWidth <real>

[UNIT#:]CHAN#:INTerferer:NBWidth?

Set the Interferer Bandwidth for the given channel of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹real›	1.625, 3.25, 6.5, 13, 26 (MHz)	6.5	—

[UNIT#:]CHAN#:INTerferer:RBWidth <real>

[UNIT#:]CHAN#:INTerferer:RBWidth?

Set the Receiver Bandwidth for the given channel of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹real›	0.1 to 26 (MHz)	3.84	0.001

[UNIT#:]CHAN#:MEASure:CTON?

Query the measured C/N ratio (in dB) for the given channel of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1

[UNIT#:]CHAN#:MEASure:CTONO?

Query the measured C/No ratio (in dB/Hz) for the given channel of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1

[UNIT#:]CHAN#:MEASure:EBNO?

Query the measured Eb/No ratio (in dB) for the given channel of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1

[UNIT#:]CHAN#:MEASure:DCYCle <real>
[UNIT#:]CHAN#:MEASure:DCYCle?

Set the Duty Cycle of the power meter for the given channel of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹real›	1 to 100 (%)	100	0.1

[UNIT#:]CHAN#:MEASure:IAVGexp <real>

[UNIT#:]CHAN#:MEASure:IAVGexp?

Set the number of input averages for the given channel's power meter of the given unit. Averages will be 2 ^ ‹real›.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹real›	1 to 31	20	1

[UNIT#:]CHAN#:MEASure:ILEVel?

Query the measured input level for the given channel of the given unit (in dBm).

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1

[UNIT#:]CHAN#:MEASure:ITYPe <string>

[UNIT#:]CHAN#:MEASure:ITYPe?

Set the Input Measurement type for the given channel's power meter of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹string›	CONTinuous, TRIGgered	CONTinuous	—

[UNIT#:]CHAN#:MEASure:OAVGexp <real>

[UNIT#:]CHAN#:MEASure:OAVGexp?

Set the number of Output Averages for the given channel's power meter of the given unit. Averages will be 2 ^ ‹real›.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹real›	1 to 31	20	1

[UNIT#:]CHAN#:MEASure:OLEVel?

Query the measured output level for the given channel of the given unit (in dBm).

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1

[UNIT#:]CHAN#:MEASure:OTYPe <string>

[UNIT#:]CHAN#:MEASure:OTYPe?

Set the Output Measurement type for the given channel's power meter of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹string›	CALCulated, MEASured	CALCulated	—

[UNIT#:]CHAN#:MEASure:TTHReshold <real>
[UNIT#:]CHAN#:MEASure:TTHReshold?

Set the Output Measurement type for the given channel's power meter of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹real›	-50 to 0 (dBm)	-30	0.1

[UNIT#:]CHAN#:NUMPaths?

Query the number of paths in the given channel of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1

[UNIT#:]CHAN#:OUTPPHAse <real>
[UNIT#:]CHAN#:OUTPPHAse?

Set the RF Port Output Phase Offset

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹real›	-360.0 to 360.0	0	0.1

[UNIT#:]CHAN#:OUTPut <real>

[UNIT#:]CHAN#:OUTPut?

Set the Output Level of the given channel of the given unit. The corresponding query will return the set output level (in dBm).

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹real›	-110 to -30 (dBm)*	-60	0.01

*: The actual range will vary based on the state of other system parameters.

[UNIT#:]CHAN#:OVERload?

Query the overload state of the given channel of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1

```
Off(0): No overload since last cleared
On(1): Overload has occurred since last cleared
```

[UNIT#:]CHAN#:PATH#:DELay:MODe <string>

[UNIT#:]CHAN#:PATH#:DELay:MODe?

Set the Delay Mode for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹string›	FIXed, SDELay, BDEath	FIXed	—

*: The number of paths set to BDeath mode cannot exceed the number of bins set using the **CHAN#:BDEath:DBINs command.v**

[UNIT#:]CHAN#:PATH#:DELay:SDELay:DMIN <real>

[UNIT#:]CHAN#:PATH#:DELay:SDELay:DMIN?

Set the Sliding Delay Minimum for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1

Parameter	Range/Selection	*RST	Resolution
‹real›	0 to 2000 (us)	0	0.0001

[UNIT#:]CHAN#:PATH#:DELay:SDELay:DMAX <real>
[UNIT#:]CHAN#:PATH#:DELay:SDELay:DMAX?

Set the Sliding Delay maximum for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹real›	0 to 2000 (us)	0	0.0001

[UNIT#:]CHAN#:PATH#:DELay:SDELay:ORATe <real>
[UNIT#:]CHAN#:PATH#:DELay:SDELay:ORATe?

Set the Sliding Delay Rate of oscillation for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹real›	0.001 to 32.767 (rad/s)	0.001	0.001

[UNIT#:]CHAN#:PATH#:DELay:SDELay:PERiod?

Query the Sliding Delay Period for the given path of the given channel in the given unit (in seconds).

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1

[UNIT#:]CHAN#:PATH#:DELay[:VALue] <real>
[UNIT#:]CHAN#:PATH#:DELay[:VALue]?

Set the Fixed Delay for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹real›	0 to 2000 (us)	0	0.0001

[UNIT#:]CHAN#:PATH#:DFRequency <real>

[UNIT#:]CHAN#:PATH#:DFRequency?

Set the Fading Doppler Frequency for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹real›	-2000 to -0.1, 0.1 to 2000 (Hz)	41.7	0.01

[UNIT#:]CHAN#:PATH#:DVELocity <real>

[UNIT#:]CHAN#:PATH#:DVELocity?

Set the Fading Doppler Velocity for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹real›	Range depends upon set Center frequency (km/h)	50	0.001

[UNIT#:]CHAN#:PATH#:FSHAPe <string>

[UNIT#:]CHAN#:PATH#:FSHAPe?

Set the Fading Spectrum Shape for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹string›	C3DB, C6DB, ROUNd, FLAT, R12DB	C6DB	—

[UNIT#]:CHAN#:PATH#:FSHift[:VALue] <real>
[UNIT#]:CHAN#:PATH#:FSHift[:VALue]?

Set the Frequency Shift for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹real›	-2000 to 2000 (Hz)	0	0.01

*: Depends upon the Doppler frequency.

[UNIT#]:CHAN#:PATH#:FSHift:MODE <string>
[UNIT#]:CHAN#:PATH#:FSHift:MODE?

Set the Frequency Shift Mode.

Parameter	Range/Selection	*RST	Resolution
‹string›	FIXed, HST	FIXed	—

[UNIT#]:CHAN#:PATH#:FSHift:HST:INIDs <real>
[UNIT#]:CHAN#:PATH#:FSHift:HST:INIDs?

Set the High Speed Train Ds (m) for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹real›	1 to 2000	300	0.1

[UNIT#]:CHAN#:PATH#:FSHift:HST:DMIN <real>
[UNIT#]:CHAN#:PATH#:FSHift:HST:DMIN?

Set the High Speed Train Dmin (m) for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹real›	1 to 200	2	0.1

[UNIT#]:CHAN#:PATH#:FSHift:HST:VELocity <real>
[UNIT#]:CHAN#:PATH#:FSHift:HST:VELocity?

Set the High Speed Train Velocity (km/h) for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹real›	10 to 500	300	0.001

[UNIT#]:CHAN#:PATH#:FSHift:HST:MAXDoppler <real>

[UNIT#]:CHAN#:PATH#:FSHift:HST:MAXDoppler?

Set the High Speed Train fd (Hz) i.e. maximum Doppler for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹real›	0 to 2000	1150	0.01

*: Depends upon the Doppler frequency.

[UNIT#]:CHAN#:PATH#:FSHift:HST:PERiod?

Query the period (s) for the High Speed Train frequency shift for the given path of the given channel in the given unit (in seconds).

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1

[UNIT#:]CHAN#:PATH#:LOGNormal:RATe <real>

[UNIT#:]CHAN#:PATH#:LOGNormal:RATe?

Set the Log Normal rate for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹real›	0 to 20	0	0.001

[UNIT#:]CHAN#:PATH#:LOGNormal:SDEViation <int>

[UNIT#:]CHAN#:PATH#:LOGNormal:SDEViation?

Set the Log Normal standard deviation for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹int›	0 to 12	0	1

[UNIT#:]CHAN#:PATH#:LOGNormal[:STATe] <bool>
[UNIT#:]CHAN#:PATH#:LOGNormal[:STATe]?

Set the Log Normal state for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹bool›	OFF, ON	OFF	—

[UNIT#:]CHAN#:PATH#:LOS:AOA <real>
[UNIT#:]CHAN#:PATH#:LOS:AOA?

Set the LOS angle of arrival for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹real›	0 to 360 (deg)	90	0.1

[UNIT#:]CHAN#:PATH#:LOS:DOPPler?

Reads the LOS Doppler for the given path of the given channel in the given unit. This parameter must be set using the: **[UNIT#:]CHAN#:PATH#:LOS:AOA** command.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹real›	-2000 to 2000 (Hz)	0	0.1

[UNIT#:]CHAN#:PATH#:LOS:KRICian <real>
[UNIT#:]CHAN#:PATH#:LOS:KRICian?

Set the Rician K factor for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1

#	1 to 24 (path)	1	1
‹real›	-30 to 30 (dB)	0	0.1

[UNIT#:]CHAN#:PATH#:MODulation <string>
[UNIT#:]CHAN#:PATH#:MODulation?
Set the Modulation Type for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹string›	NONE, RAYLeigh, RICian	NONE	—

[UNIT#:]CHAN#:PATH#:PHSHift <real>
[UNIT#:]CHAN#:PATH#:PHSHift?

Set the Phase Shift for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹real›	0 to 360 (deg)	0	0.1

[UNIT#:]CHAN#:PATH#:RPLoss <real>
[UNIT#:]CHAN#:PATH#:RPLoss?

Set the Relative Path Loss for the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹real›	0 to 32 (dB)	0	0.1

[UNIT#:]CHAN#:PATH#[:STATe] <bool>
[UNIT#:]CHAN#:PATH#[:STATe]?

Enable or disable the given path of the given channel in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
#	1 to 24 (path)	1	1
‹bool›	OFF, ON	OFF	—

[UNIT#:]CHAN#:RFOUTput <bool>
[UNIT#:]CHAN#:RFOUTput?

Enable or disable the RF Output of the given channel of the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 2 (channel)	1	1
‹bool›	OFF, ON	ON	—

[UNIT#:]CONFiguration <string>
[UNIT#:]CONFiguration?

Set the Channel Configuration for the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
‹string›	SINGle, DUAL, RXDiversity, TXDiversity, MIMO, MIMO4x4	DUAL	—

[UNIT#:][EMULation:]PAUSe

Pause the player for the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1

[UNIT#:][EMULation:]PLAY

Play the player for the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1

[UNIT#:][EMULation:]STOP

Stop the player for the given unit.

Parameter	Range/Selection	*RST	Resolution

#	1 to 4 (unit)	1	1

[UNIT#:][EMULation:]STATe?

Query the Player Status for the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1

[UNIT#:]MIMO:PHSHift <Sink Index>,<Source Index>,<real>
[UNIT#:]MIMO:PHSHift <Sink Index>,<Source Index>?

Set the Phase of the MIMO Sub-Channels.

This command is available only in MIMO mode (2x2, 4x4).

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
‹Sink Index›	1 to 2 (2x2 MIMO) 1 to 4 (4x4 MIMO)	1	1
‹Source Index›	1 to 2 (2x2 MIMO) 1 to 4 (4x4 MIMO)	1	1
‹real›	0 to 360 (deg)	0	0.1

[UNIT#:]MIMO:RELPower <Sink Index>,<Source Index>,<real>
[UNIT#:]MIMO:RELPower <Sink Index>,<Source Index>?

Set the Relative Power between the MIMO Sub-Channels.

This command is available only in MIMO mode (2x2, 4x4).

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
‹Sink Index›	1 to 2 (2x2 MIMO) 1 to 4 (4x4 MIMO)	1	1
‹Source Index›	1 to 2 (2x2 MIMO) 1 to 4 (4x4 MIMO)	1	1
‹real›	-30 to 30 (dB)	0	0.01

[**UNIT#:]MIMO:STATe <Sink Index>,<Source Index>,<**bool**>**
[UNIT#:]MIMO:STATe <Sink Index>,<Source Index>?

Set the State of the MIMO Sub-Channels.

This command is available only in MIMO mode (2x2, 4x4).

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
‹Sink Index›	1 to 2 (2x2 MIMO)	1	1

Parameter	Range/Selection	*RST	Resolution
	1 to 4 (4x4 MIMO)		
‹Source Index›	1 to 2 (2x2 MIMO) 1 to 4 (4x4 MIMO)	1	1
‹bool›	OFF, ON	ON	—

[UNIT#:]NUMCHannels?

Query the number of channels in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1

[UNIT#:]RELPower <real>
[UNIT#:]RELPower?

Set the Relative Power between channels in the given unit. This command is available in TX Diversity mode only.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
‹real›	-30 to 30 (dB)	0	0.1

[UNIT#:]ROSCillator?

Query the state of the reference oscillator in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1

[UNIT#:]GCM:BSAConfig <string>
[UNIT#:]GCM:BSAConfig?

Set the BS Antenna Configuration for the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
‹string›	CROSs, VERTical	VERTical	—

[UNIT#:]GCM:BSASpacing <real>
[UNIT#:]GCM:BSASpacing?

Set the BS Antenna Spacing for the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
‹real›	0.1 to 100 (λ)	0.1	0.1

[UNIT#:]GCM:DIRection <string>
[UNIT#:]GCM:DIRection?

Set the Link Direction for the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
‹string›	UL, DL	DL	—

[UNIT#:]GCM:MSAConfig <string>
[UNIT#:]GCM:MSAConfig?

Set the MS Antenna Configuration for the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
‹string›	CROSs, VERTical	VERTical	—

[UNIT#:]GCM:MSASpacing <real>
[UNIT#:]GCM:MSASpacing?

Set the MS Antenna Spacing for the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
‹real›	0.1 to 100 (λ)	0.1	0.1

[UNIT#:]GCM:XPD <real>
[UNIT#:]GCM:XPD?

Set the Cross Polarization Discrimination for the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
‹real›	3 to 15 (dB)	6	0.1

[UNIT#:]GCM:PATH#:AOA <real>
[UNIT#:]GCM:PATH#:AOA?

Set the mean Angle of Arrival for the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1
‹real›	-180 to 180 (deg)	0	0.1

[UNIT#:]GCM:PATH#:AOD <real>
[UNIT#:]GCM:PATH#:AOD?

Set the mean Angle of Departure for the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1
‹real›	-180 to 180 (deg)	0	0.1

[UNIT#:]GCM:PATH#:BSAS <real>
[UNIT#:]GCM:PATH#:BSAS?

Set the Angle Spread at the BS for the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1
‹real›	1 to 75 (deg)	2	0.1

[UNIT#:]GCM:PATH#:BSPAS <string>
[UNIT#:]GCM:PATH#:BSPAS?

Set the BS Power Azimuth Spectrum for the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1
‹string›	LAPLacian, GAUSsian, UNIForm	LAPLacian	—

[UNIT#:]GCM:PATH#:DELay:MODE?

Query the Delay Mode for the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1

FIXed: Fixed Delay Mode

[UNIT#:]GCM:PATH#:DELay[:VALue] <real>
[UNIT#:]GCM:PATH#:DELay?

Set the Fixed Delay for the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1
‹value›	0 to 2000 (us)	0	0.0001

[UNIT#:]GCM:PATH#:DELay:LOS[:STATe] <string>
[UNIT#:]GCM:PATH#:DELay:LOS[:STATe]?

Set the state of Line-of-Sight (LoS) component for the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1
‹string›	OFF, ON	OFF	—

[UNIT#:]GCM:PATH#:DELay:LOS:AOA <real>
[UNIT#:]GCM:PATH#:DELay:LOS:AOA?

Set the angle of arrival of the LoS component for the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1
‹real›	-180 to 180 (deg)	0	0.1

[UNIT#:]GCM:PATH#:DELay:LOS:AOD <real>
[UNIT#:]GCM:PATH#:DELay:LOS:AOD?

Set the angle of departure of the LoS component for the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1
‹real›	-180 to 180 (deg)	0	0.1

[UNIT#:]GCM:PATH#:DELay:LOS:DOPPler?

Query the LoS doppler for the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution

#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1

[UNIT#:]GCM:PATH#:DELay:LOS:KFACtor <real>
[UNIT#:]GCM:PATH#:DELay:LOS:KFACtor?

Set the K Factor of the LoS component for the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1
‹real›	-30 to 30 (dB)	0	0.1

[UNIT#:]GCM:PATH#:MIDPath#:EXCDelay <real>
[UNIT#:]GCM:PATH#:MIDPath#:EXCDelay?

Set the Excess Delay for the given Midpath of the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1
‹real›	0 to 2000 (us)	0	0.0001

[UNIT#:]GCM:PATH#:MIDPath#:NUMScatterers?

Query the Number of Scatterers for the given Midpath of the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1

[UNIT#:]GCM:PATH#:MIDPath#:RELPower?

Query the Relative Power (in dB) for the given Midpath of the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1

[UNIT#:]GCM:PATH#:MIDPATHS[:STATe] <string>
[UNIT#:]GCM:PATH#:MIDPATHS[:STATe]?

Set the state of Midpaths for the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1

#	1 to 24 (path)	1	1
‹string›	OFF, ON	OFF	—

[UNIT#:]GCM:PATH#:MODulation <string>
[UNIT#:]GCM:PATH#:MODulation?

Set the modulation type for the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1
‹string›	NONE, RAYLeigh	NONE	—

[UNIT#:]GCM:PATH#:MSAS <real>
[UNIT#:]GCM:PATH#:MSAS?

Set the Angle Spread at the MS for the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1
‹real›	1 to 75 (deg)	35	0.1

[UNIT#:]GCM:PATH#:MSDirection <real>
[UNIT#:]GCM:PATH#:MSDirection?

Set the angle of MS velocity with respect to the MS broadside for the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1
‹real›	-180 to 180 (deg)	0	0.1

[UNIT#:]GCM:PATH#:MSPAS <string>
[UNIT#:]GCM:PATH#:MSPAS?

Set the MS Power Azimuth Spectrum for the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1
‹string›	LAPLacian, GAUSsian, UNIForm	LAPLacian	—

[UNIT#:]GCM:PATH#:MSVelocity <real>

[UNIT#:]GCM:PATH#:MSVelocity?

Set the velocity of the MS for the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1
‹real›	0 to 5400 (km/h)	10	0.1

[UNIT#:]GCM:PATH#:NUMMidpaths?

Query the Number of Midpaths for the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1

[UNIT#:]GCM:PATH#:NUMScatterers?

Query the total Number of Scatterers for the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1

[UNIT#:]GCM:PATH#:RPLoss <real>
[UNIT#:]GCM:PATH#:RPLoss?

Set the Relative Path Loss for the given path in the given unit.

Parameter	Range/Selection	*RST	Resolution
#	1 to 4 (unit)	1	1
#	1 to 24 (path)	1	1
‹real›	0 to 32 (dB)	0	0.1

6.4. Command Dependencies

Many of the commands and queries listed above have ranges dependent upon other settings. The SR5500 parameter dependency tree is shown below. Setting commands at a higher level of the tree may change the values in lower levels of the tree. When this occurs, the RPI status screen indicates that the parameters have changed, but this does not generate an error viewable by the remote operator. In order to guarantee that the settings match the desired values, we recommend that you move down the parameter tree when changing settings. For example, you should set the Crest Factor before setting the output level, and then the C/I ratio.

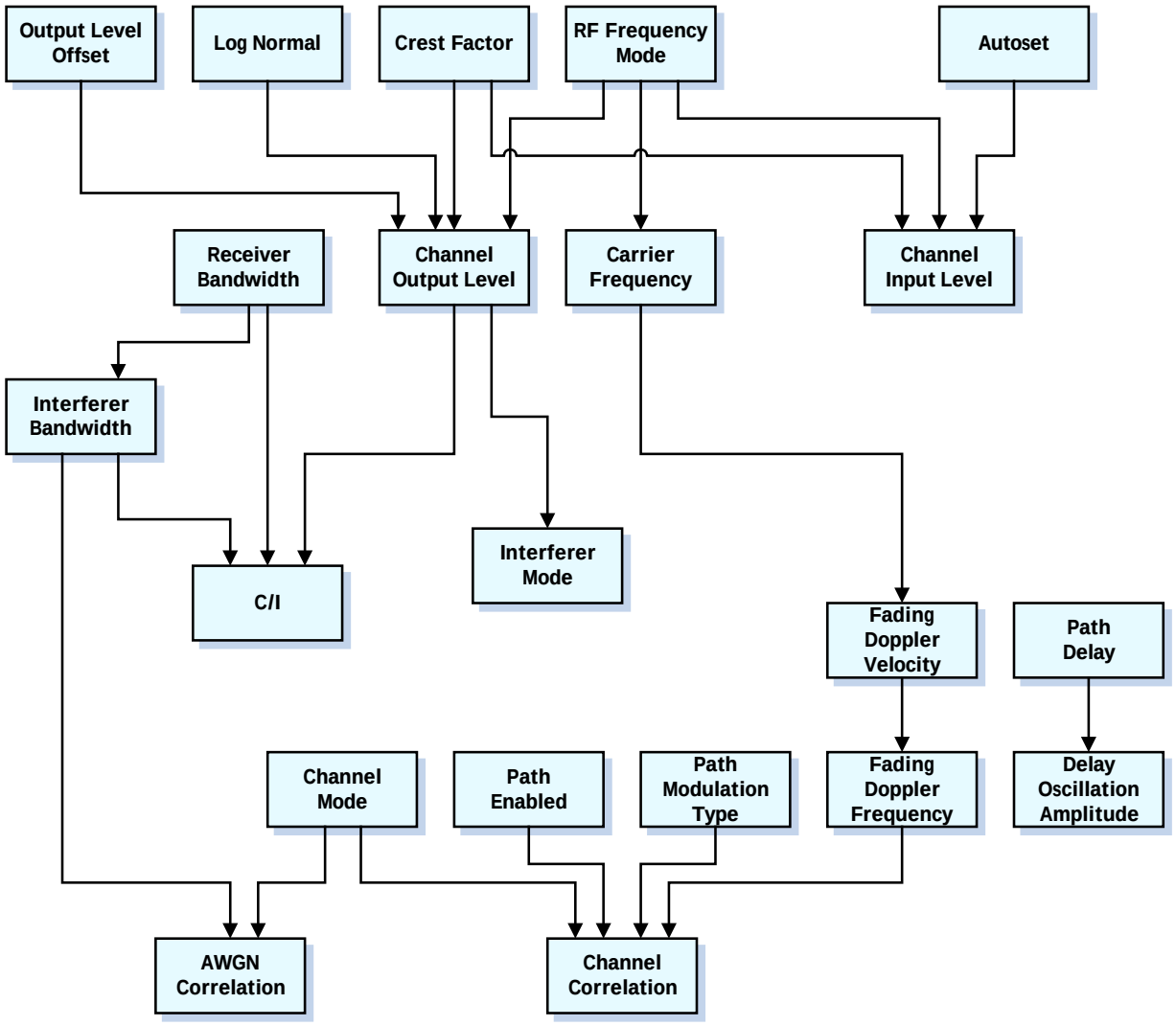


Figure 6-2: SR5500 Parameter Dependency Tree

6.5. Autoset

To perform an Autoset, send the following commands:

```
UNIT#:CHAN#:BAUToset
```

Begins the Autoset.

```
UNIT#:CHAN#:ASTatus?
```

Checks the Status of the Autoset.

This command should be repeated until “Complete” or an error is returned. New commands cannot be sent to the system until the Autoset is complete.

6.6. Overload Status

TestKit stores the overload status of each channel so that instantaneous overloads can be detected by the software.

To query the overload status:

```
[UNIT#:]CHAN#:OVERload?
          To clear the overload register:
[UNIT#:]CHAN#:CLROVerload
```

NOTE: Performing an Autoset automatically clears the overload register.

6.7. Dynamic Environment Emulation (DEE)

To use the Dynamic environment emulation feature using the RPI, commands must be sent in a very specific order. Manually complete the test run before running DEE to verify that the state file compiles properly, and that no errors occur.

1. Use the DEE:COMP:FILEn command to set the DEE files for each instrument (where n is the unit #). For example, if the GUI is in 2 unit mode:
   DEE:COMP:FILE1 "C:\Documents and Settings\My Documents\DEE Files\DEEFile1.stb"
   DEE:COMP:FILE2 "C:\Documents and Settings\My Documents\DEE Files\DEEFile2.stb"
2. Use the DEE:COMP:BEG command to begin compilation of the files.
   DEE:COMP:BEG
3. Use the DEE:COMP:STAT? command to query the compile status and wait for "Completed" message.
   DEE:COMP:STAT?
4. Repeat Step 3 until either “Completed” or “Failed” is returned. If the message comes back as "Failed" there was a compile error. IF DESIRED, Use DEE:COMP:ABORT command to abort the compile.

5. When the compile has completed, use DEE:STATE ON command to enable DEE.
   DEE:STATE ON

NOTE: This can take some time to complete execution. Once Enabled, the only commands accepted are enumerated below. Other commands will fail.

6. Use the PLAY command to begin playing the DEE profile.
   PLAY
7. Use the PAUSE command to pause the DEE playback, or use STOP to stop the DEE playback and reset it back to state 1.
   PAUSE
8. Use the DEE:CSTAT? command to query the current state number.
   DEE:CSTAT?
9. Use the DEE:CLOOP? command to query the current dee loop number.
   DEE:CLOOP?
10. Use the DEE:ETIM? command to query the elapsed time indicator.
    DEE:ETIM?
11. Use the DEE:STAT OFF command to disable DEE.
    DEE:STAT OFF

This returns the unit to non-DEE mode. Other commands may now be sent to the unit.

6.8. Fading Playback

To use the Fading Data Playback feature using the RPI, commands must be sent in a very specific order. In the following sample, “n” is the unit number.

1. Use the FADL:FDP:UNITn:FILE command to set the Fading Data Playback file for each instrument. For example, if the GUI is in 2 unit mode:
   FADL:FDP:UNIT1:FILE "C:\Documents and Settings\My Documents\Fading Data Playback Files\FDPFile1.cpf"
   FADL:FDP:UNIT2:FILE "C:\Documents and Settings\My Documents\Fading Data Playback Files\FDPFile2.cpf"
2. Use the FADL:FDP:UNITn:REPR command to query the repetition rate of the Fading Data Playback file. For example, to get the repetition rate for unit2:
   FADL:FDP:UNIT2:REPR?
3. Use the FADL:FDP:UNITn:BDOW command to begin the download of the Fading Data Playback file.
   FADL:FDP:UNIT2:BDOW
4. Use the FADL:FDP:UNITn:DPR and FADL:FDP:UNITn:DST command to query the download status . For instance:
   FADL:FDP:UNIT2:DST?
   FADL:FDP:UNIT2:DPR?
5. IF DESIRED, Use the FADL:FDP:UNITn:DAB command to abort the download.

6. Repeat Step 4 until the status is either “Completed” or “Failed” (the progress would return a 100 if the status is completed). If the message comes back as "Failed" there was an error during download. The FADL:FDP:UNITn:DPR command would return the percent at which the download failed in case there was a download error.
7. When the download has completed, use the FADL:FDP:STATE ON command to enable Fading Data Playback.
   FADL:FDP:STATE ON

NOTE: This can take some time to complete execution. Once Enabled, only commands to change the channel parameters and AWGN are accepted. Other commands will fail.

8. Use the PLAY command to begin playing the Fading Data.
   PLAY
9. Use the PAUSE command to pause the Fading Data playback engine, or use STOP to stop Fading Data playback engine.
   PAUSE
   STOP
10. Use the FADL:FDP:UNITn:ETIM command to query the elapsed time indicator.
    FADL:FDP:UNIT2:ETIM?
11. Use the FADL:FDP:UNITn:CLOOP command to query the current loop number.
    FADL:FDP:UNIT2:CLOOP?
12. Use FADL:FDP:STATE OFF command to disable Fading Data Playback.
    FADL:FDP:STATE OFF

This returns the unit to non-Fading Data Playback mode. Other commands may now be sent to the unit.

7. Technical Specifications

7.1. Overview

The following specifications describe warranted performance over the temperature range 0-40 degrees C and include a 30 minute warm-up time from ambient conditions. Supplemental characteristics are in italics and provide useful information by giving non-warranted performance parameters. The specifications are measured under the following channel conditions unless otherwise indicated:

- RF Input Level = -10 dBm (CW Signal)
- RF Output Level = -30 dBm (or maximum allowed)
- One Path On, Path Status = Static, Path Frequency Shift = fixed at 0 Hz, Path Delay = fixed at 0 µs
- Channel Configuration = Dual RF Channel
- AWGN Off
- Channel Crest Factor = 15 dB
- Log-Normal OFF

NOTE: Technical Specifications are subject to change without notice.
Items marked with a * are optional features.

7.2. RF Channel Specifications

Center Frequency Range	400 to 2700 MHz
Center Frequency Resolution	0.1 MHz
Channel Bandwidth	26 MHz
Channel Flatness	
Amplitude Variation	*+/- 1 dB*
Group Delay Distortion	*±30 ns*
Phase Distortion from Linear	*± 5 degrees*
Number of Independent RF Channels	2

7.2.1. Input Signal Level

Input Signal level	+5 to -50 dBm
Autoset Range	+5 to -32 dBm (Crest Factor 15dB)
Damage Level	+20 dBm

7.2.2. Output Signal Level

Range	-30 to -110 dBm
Resolution	0.1 dB
Accuracy	*+/- 1 dB*
Damage Level	+20 dBm

7.2.3. Channel Crest Factor

Range	15 to 35 dB
Effect on I/O Ranges	Max Input Level = (15 – Crest Factor Setting) dBm Min Input Level = (-15 – Crest Factor Setting) dBm Max Output Level=(-15 – Crest Factor Setting) dBm Min Output Level = -110 dBm
Absolute Channel Delay	
In to Out	*< 4.0 µs*

7.2.4. Spurious Emission Levels

Spurious Emission Levels	
Within Channel	- 40 dBc maximum
Outside Channel within 400 to 2700 MHz	-10 dBc maximum

7.2.5. Residual EVM

Better than -36 dB, typical per subcarrier measured at -50 dB output power; actual value depends upon signal format, symbol rate, etc.

7.2.6. Noise Floor

The specifications are measured under the following conditions:

- RF Input Level = -10 dBm (CW Signal)
- Frequency = 2.14 GHz
- The Noise Floor of the Spectrum Analyzer was compensated.
- Analyzer has the best commercially available Noise Figure.

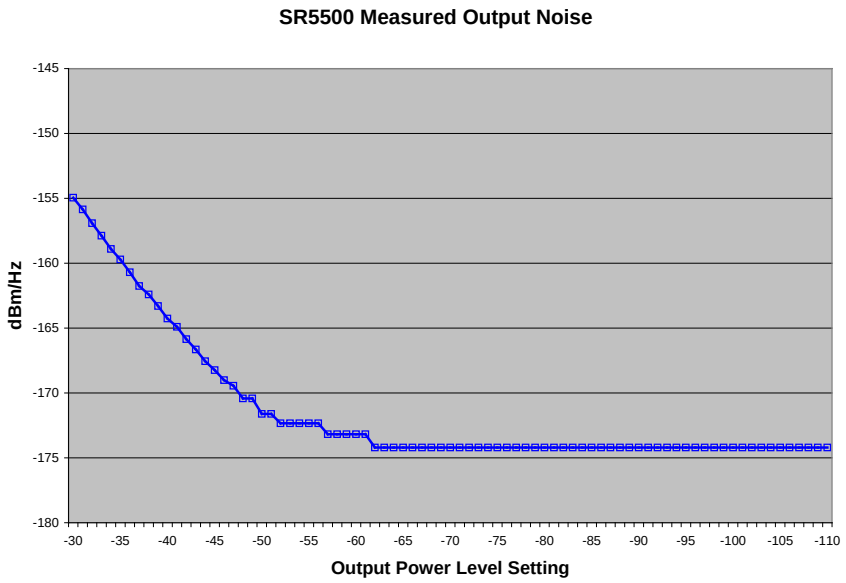


Figure 7-1: SR5500 – Noise Floor

Stepped response comes from finite precision (0.1 dB) of measurement data

7.2.7. RF Physical Interface Characteristics

Impedance	50 ohms
Input VSWR	‹ 1.5
Connector Type	N Female (Front Panel)
	CH1 RF In, CH1 RF Out
	CH2 RF In, CH2 RF Out
Bypass Mode Insertion Loss	*12 dB*

7.3. RF Channel Specifications (with the SR5500 6 GHz Option)*

The channel specifications for the SR5500 equipped with the SR5500 6 GHz RF Converter are the same as in section 5.2 with the following exceptions.

Frequency Range	400 to 2700 MHz and 4100 to 6000 MHz

7.3.1. Input Signal Level

Autoset Range (400 to 2700 MHz)	0 to -30 dBm
Autoset Range (4100 to 6000 MHz)	-10 to -30 dBm
Damage Level	+20 dBm

7.3.2. Output Signal Level

Range (400 to 2700 MHz)	-30 to -110 dBm
Range (4100 to 6000 MHz)	-40 to -80 dBm
Resolution	0.1 dB
Accuracy	*+/- 1 dB*
Damage Level	+20 dBm

7.3.3. Channel Crest Factor

Range	15 to 35 dB
Effect on I/O Ranges (400 to 2700 MHz)	Max Input Level = (15 – Crest Factor Setting) dBm Min Input Level = (-15 – Crest Factor Setting) dBm Max Output Level=(-15 – Crest Factor Setting) dBm Min Output Level = -80 dBm
Effect on I/O Ranges (4100 to 6000 MHz)	Max Input Level = (5 – Crest Factor Setting) dBm Min Input Level = (-15 – Crest Factor Setting) dBm Max Output Level=(-25 – Crest Factor Setting) dBm Min Output Level = -80 dBm

7.3.4. Spurious Emission Levels

Within Channel	-40 dBc maximum
Outside Channel but within 400 to 2700 MHz and 4100 to 6000 MHz	-10 dBc maximum

7.3.5. RF Physical Interface Characteristics

Impedance	*50 ohms*
Input VSWR	*‹ 1.5*
Connector Type	N Female (6 GHz RF Converter front panel)
	CH1 RF In, CH1 RF Out
	CH2 RF In, CH2 RF Out

Bypass Mode Insertion Loss 20 dB

7.4. RF Channel Specifications (with the SR5500 6 GHz-EX Option)*

The channel specifications for the SR5500 equipped with the SR5500 6 GHz-EX RF Converter are the same as in Section 7.2 with the following exceptions.

Frequency Range	400 to 2700 MHz and
	3300 to 3850 MHz and
	4100 to 6000 MHz

7.4.1. Input Signal Level

Autoset Range (400 to 2700 MHz) 0 to -30 dBm

Autoset Range (3300 to 3850 MHz)	-10 to -30 dBm
Autoset Range (4100 to 6000 MHz)	-10 to -30 dBm
Damage Level	+20 dBm

7.4.2. Output Signal Level

Range (400 to 2700 MHz)	-30 to -110 dBm
Range (3250 to 3850 MHz)	-35 to -110 dBm
Range (4100 to 6000 MHz)	-40 to -80 dBm
Resolution	0.1 dB
Accuracy	*+/- 1 dB*
Damage Level	+20 dBm

7.4.3. Channel Crest Factor

Range	15 to 35 dB
Effect on I/O Ranges (400 to 2700, MHz)	Max Input Level = (15 – Crest Factor Setting) dBm Min Input Level = (-15 – Crest Factor Setting) dBm Max Output Level=(-15 – Crest Factor Setting) dBm Min Output Level = -110 dBm
Effect on I/O Ranges (3300 to 3850, MHz)	Max Input Level = (5 – Crest Factor Setting) dBm Min Input Level = (-15 – Crest Factor Setting) dBm Max Output Level=(-20 – Crest Factor Setting) dBm Min Output Level = -100 dBm
(4100 to 6000 MHz)	Max Input Level = (5 – Crest Factor Setting) dBm Min Input Level = (-15 – Crest Factor Setting) dBm Max Output Level=(-25 – Crest Factor Setting) dBm Min Output Level = -80 dBm

7.4.4. Spurious Emission Levels

Within Channel	-40 dBc maximum
Outside Channel but within 400 to 2700 MHz, 3300 to 3850 MHz, or 4100 to 6000 MHz	-10 dBc maximum

7.4.5. RF Physical Interface Characteristics

Impedance	*50 ohms*
Input VSWR	*‹ 1.5*
Connector Type	N Female (6 GHz-EX RF Converter front panel)
	CH1 RF In, CH1 RF Out
	CH2 RF In, CH2 RF Out
Bypass Mode Insertion Loss	*20 dB*

7.5. RF Channel Specifications (with the EOP 4GHz Hardware Option)*

The channel specifications for the SR5500 equipped with the EOP 4 GHz Hardware are the same as in Section 7.2 with the following exceptions.

7.5.1. Output Signal Level

Range (400 to 2700 MHz)	-20 to -110 dBm
Range (3250 to 3850 MHz)	-35 to -110 dBm
Range (4100 to 6000 MHz)	-40 to -80 dBm
Resolution	0.1 dB
Accuracy	+/- 1 dB
Damage Level	+20 dBm

7.5.2. Channel Crest Factor

Range	15 to 35 dB
Effect on I/O Ranges (400 to 2700, MHz)	Max Input Level = (15 – Crest Factor Setting) dBm
	Min Input Level = (-15 – Crest Factor Setting) dBm
	Max Output Level = (-5 – Crest Factor Setting) dBm
	Min Output Level = -110 dBm
Bypass Mode Insertion Loss	
Range (400 to 2700 MHz)	12 dB
Range (3250 to 3850 MHz)	x dB
Range (4100 to 6000 MHz)	y dB

7.6. Channel Emulation Characteristics

7.6.1. Number of Paths per Channel

Dual Channel Mode	12 per channel x 2 channels (24 Total)
Single Channel Mode	24 per channel x 1 channel (24 Total)
TX Diversity Mode	12 per channel x 2 channels (24 Total)
RX Diversity Mode	12 per channel x 2 channels (24 Total)
2x2 MIMO Channel Mode*	24 per channel x 4 channels (96 Total)
4x4 MIMO Channel Mode*	24 per channel x 16 channels (384 Total)

7.6.2. Path Characteristics

Path Status	On, Off,
Modulation (Fading) Types	Static (None), Rayleigh, Rician, Log-Normal Delay Mode Fixed Sliding (sinusoidal) Birth-Death

7.6.3. Frequency Shift

Fixed Frequency Shift	
Range	± 0.01 to ± 2000.00 Hz
Resolution	0.01 Hz
High Speed Train Shift	
D_s	1 to 2000 m
D_{min}	1 to 200 m
Resolution (D_s and D_{min})	0.1 m
Velocity	10 to 500 km/h
Resolution	0.001 km/h
f_d	0 to 2000 Hz
Resolution	0.01 Hz

7.6.4. Phase Shift

Range	0 to 360 degrees
Resolution	0.1 degrees

7.6.5. Path Loss Characteristics

Relative Path Loss	
Range (with multiple paths enabled)	0 to 32 dB
Resolution	0.1 dB
Accuracy	*+/- 0.1 dB*

7.6.6. Path Delay Characteristics

Fixed Delay	
Range	0 to 2000 µsec
Resolution	0.1 nsec
Accuracy	*+/- 0.5 nsec*
Sinusoidal Delay	
Start and Stop Delay Range	0 to 2000 µsec
Resolution	0.1 nsec
Oscillation Rate	0.001 to 32.767 Hz
Resolution	0.001 Hz
Birth-Death Delay	
Number of Delay Bins	1 to 64
Delay Bin Range	0 to 2000 µsec
Resolution	0.1 nsec
State Duration	0.001 to 60 sec
Resolution	0.001 sec

7.6.7. Path Fading Characteristics

Fading (Rayleigh) Amplitude Distribution	
Deviation from Theoretical CPDF exceeds the following requirements:	
From +10 to -30 dB of mean power level	*± 0.5 dB*
Level Crossing Rate (LCR) Accuracy exceeds the following requirements):	
From +3 to -30 dB of mean power level	*‹ ± 2.5% deviation theoretical LCR curve of the simulated vehicle velocity*

7.6.8. Fading Power Spectrum

Programmable shapes:	Classical 6 dB, Flat, Classical 3 dB, Rounded, Rounded 12 dB
Fading Repetition Interval	*› 24 hours*
Fading Velocity	
Range (f_c = 900 MHz)	± 0.1 to ± 2398.33 km/h
Resolution	0.1 km/h
Fading Doppler Frequency	
Range	0.01 to 2000 Hz
Resolution	0.01 Hz
Accuracy	*+/-* 0.25% of set Fading Doppler.

7.6.9. Rician Fading Characteristics

Line of Site (LOS) Arrival Angle	
Range	0 to 360 degrees
Resolution	0.1 degrees
Rician K Factor	
Range -	30 to +30 dB
Resolution	0.1 dB

7.6.10. Log-Normal Fading Characteristics

Enabled	Yes, No
Rate	
Range	0.00 to 20.00 Hz
Resolution	.01 Hz
Standard Deviation	
Range	0 to 12 dB
Resolution	1 dB
Minimum Actual Amplitude Variation	2 sigma (2 * Standard Deviation)

7.6.11. Dynamic Environment Emulation (DEE)

Channel Modes	Available in Single, Dual, Rx Diversity, TX Diversity and 2x2 MIMO Channel Modes
Playback Modes	Play Once, Loop Continuously.
Trigger Modes	Free run, Triggered Play
Settable Parameters	State Duration, Output Power Level, AWGN Status (ON/OFF), C/N Ratio, Path Status (ON/OFF), Path Delay, Path Relative Loss, Rician Line of Sight Angle of Arrival, Rician K Factor, Frequency Shift, Doppler Velocity, MIMO Sub-Channel State, MIMO Sub-Channel Relative Power and MIMO Sub-Channel Phase.
Minimum State Time	10 ms (Filter Nose Channel models) 200 ms (SOS Channel models)
Minimum Number of States	2
Maximum Number of States	65535
Maximum State Transition Time:	
RF Output Level Changes	2 ms. (Measured from start of state change to completion of state change)
All Other Changes	400 µs (Measured from start of state change to completion of state change)

7.6.11.1 DEE Trigger Characteristics

Trigger Signal	TTL, Rising Edge
Trigger Signal Power	3.3 V
Minimum Trigger Width	90 ns
Trigger Delay - from Trigger to	
Change in Output Level	‹ 5.0 ms
Change in other parameters	‹ 1.0 ms

7.6.12. Fading Playback

Channel Modes	Available in 2x2 MIMO Channel Mode
Settable Parameters	I, Q Values, Delay for the paths, Number of paths
I,Q Range	-1.0000 to 1.0000
I, Q Resolution	0.0001
Delay Range	0.0 to 2000000.0 ns
Delay Resolution	.1 ns
Sampling Rate	5 KHz
Minimum Duration of Playback	10 sec
Maximum Duration of Playback	9 min
Minimum Fading Data Playback File Size	28.800032 MB
Maximum Fading Data Playback File Size	1.5552 GB

7.6.13. Multi Antenna

Modes	Receive Diversity, Transmit Diversity, Multiple Input/Multiple Output (MIMO 2x2 and 4x4)
Settable Parameters	Relative Channel Power (TX Diversity, MIMO), Selectively Enable Sub-channels (MIMO), Phase (MIMO).
Relative Channel Power Range	30 dB
Relative Channel Power Accuracy	*0.1 dB (Relative power difference < 10 dB)* *0.3 dB (Relative power difference < 20 dB)* *1.0 dB (Relative power difference < 30 dB)* *(Valid when* both *signals are of the same type and at the same frequency. If signals are at different frequencies, accuracy is affected by channel flatness)*
Phase Range	-360.0 to 360.0 degrees
Phase Resolution	0.1 degrees

7.6.14. Path Rayleigh Fading Correlation

Modes	Envelope, Component, Complex*
Range	0.0 to 1.0
Correlation Matrices	All semi-positive definite matrices
Resolution	
Envelope, Component Correlation	0.01
Complex Correlation	0.0001

7.7. Interference Generation Characteristics

Independent Interference Generators per Channel:	1

7.7.1. Interference Characteristics

Type	AWGN*
BW	26, 13, 6.5, 3.25, 1.625 MHz
	Refer to the Technical Reference for the spectral shape of the AWGN over the aforementioned bandwidths.
Ratio Units	C/N in dB
	C/No in dB/Hz
	Eb/No in dB/Hz
Ratio Range	-30 to +32 dB in C/N units

NOTE: The range for the ratio is dependent on the carrier output conditions.

7.7.2. AWGN Correlation

Range	0.0 or 1.0

7.7.3. AWGN Performance

Flatness across specified noise bandwidth

Noise Bandwidth <= 13 MHz	*< 0.5 dB Peak Ripple*
Noise Bandwidth <= 26 MHz	*< 1 dB Peak Ripple*

Accuracy

(Measured relative to a user signal which is flat in power across the receiver bandwidth. Output power set to maximum.)

All Receiver Bandwidths

C/N Ratio from -30 to -25 dB	*+/- 0.4 dB*
C/N Ratio from -25 to -20 dB	*+/- 0.2 dB*
C/N Ratio from -20 to 15 dB	*+/- 0.1 dB*
C/N Ratio from 15 to 20 dB	*+/- 0.2 dB*
C/N Ratio from 20 to 30 dB	*+/- 0.3 dB*
C/N Ratio from 30 to 32 dB	*+/- 0.4 dB*
Sequence Duration	› 2 hours
Crest Factor	0.001% of the time the AWGN source shall exceed 10 dB PAR (per UMTS specifications)

Refer to Technical Specifications for a typical CCDF of the AWGN source.

7.8. Power Measurement Characteristics

Number of Independent Power Meters per Channel	One at each channel input One at each channel output (continuous mode only)
Trigger Types	Continuous, Triggered
Trigger Level Range	-50 to 0 dBm
Averages	2^x where $2 \leqslant x \leqslant 31$ (0.206 µsec per average)
TestKit Power Meter Update Rate	2 Hz

7.9. Interface and Environmental Characteristics

7.9.1. SR5500 Front Panel Indicators

Channel Overload	1 LED indicator/channel
Channel Bypass	1 LED indicator/channel
Status	1 LED indicator
LCD Display*	40 character X 2 Line Display
Port Enabled*	1 LED indicator/RF Port
MIMO Enabled*	1 LED indicator

7.9.2. SR5500 Power Requirements

Voltage	85-250 VAC (auto sensing)
Frequency	47-63 Hz
Power	300 Watt (maximum)
Fuse Type	10 Amp, 250 Volt slow-blow fuse
Number of Fuses	2
Fuse Location Conductor	Hot conductor, Neutral

7.9.3. 6GHz(-EX) Option Power Requirements

Voltage	100-240 VAC (auto sensing)
Frequency	50-60 Hz
Power	45 Watt (maximum)
Fuse Type	3 Amp, 250 Volt slow-blow fuse
Number of Fuses	1
Fuse Location Conductor	Hot conductor

7.9.4. Operating Environment

Temperature	*0 to 40 degrees C*
Humidity	*10% to 90%, noncondensing*

7.9.5. SR5500 Dimensions and Weight

Height	8.75 inches
Width	16.88 inches
Depth	21 inches
Weight	*65 pounds*

7.9.6. 6 GHz Option Dimensions and Weight

Height	3.5 inches
Width	17 inches
Depth	14.4 inches
Weight	*15 pounds*

7.9.7. SR5500 Control Interfaces

Interfaces Provided	Ethernet
Interface Access	COM API (support limited to MS Windows Operating Systems)
System Configuration Interfaces Provided	RS-232

7.9.8. 10 MHz Reference Requirements

External 10 MHz Reference Input	
Connector Type	50Ω BNC connector (rear)
Input Level Range	0 dBm +/- 2 dB
Input Level PPM from	10 MHz‹ 2 PPM
Internal 10 MHz Reference	
Connector Type	50Ω BNC connector (rear)
Output Level Range	*0 dBm*
Type	OCXO
Accuracy	*‹ 1 PPM*

SR5500 Fuse Replacement Procedure

The fuse is installed at the factory to match the most commonly used line voltage in the country of destination.

CAUTION: Disconnect from the supply before servicing.

1. Locate the power entry module on rear panel.
2. Using a small screwdriver, pry out the fuse holder using the notch at the top of the power entry module. Refer to diagram below.

3. Pull the fuse from the fuse holder as shown above.
4. To reinstall, select the proper fuse and place in the fuse holder.

Part Number	Type
1800-6776	10A 250V Slow-Blow Fuse

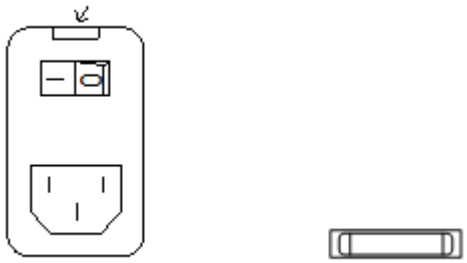
5. Reinsert the fuse holder into the power entry module.

6 GHz Option Fuse Replacement Procedure

The fuse is installed at the factory to match the most commonly used line voltage in the country of destination.

CAUTION: Disconnect from the supply before servicing.

1. Locate the power entry module on rear panel.
2. Using a small screwdriver, pry out the fuse holder using the notch at the top of the power entry module. Refer to diagram below.



3. Pull the fuse from the fuse holder as shown above.
4. To reinstall, select the proper fuse and place in the fuse holder.

Part Number	Type
1800-7789	3A 250V Slow-Blow Fuse

5. Reinsert the fuse holder into the power entry module.

SR5500 Procédure de Remplacement de Fusible

Le fusible d'origine est dimensionné selon le voltage le plus courant dans le pays de destination.

ATTENTION – Déconnecter de l'alimentation avant l'opération.

1. Localiser le module d'entrée d'alimentation sur le panneau arrière.
2. Avec un petit tournevis, enlever le support à fusible en utilisant l'encoche au sommet du module d'entrée d'alimentation (voir le schéma ci-dessous).

3. Enlever le fusible du support comme montré ci-dessus.
4. Pour remise en état, sélectionner le fusible approprié et le placer sur le support.

Numero du Composant	Type
1800-6776	10A 250V Fusible temporisé

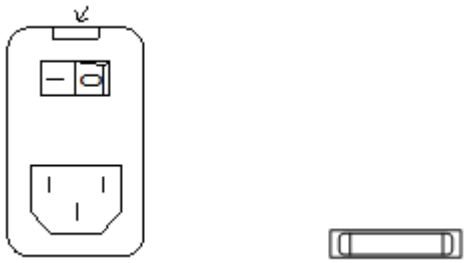
5. Réinstaller le support de fusible dans le module d'entrée d'alimentation.

6 GHz Option Procédure de Remplacement de Fusible

Le fusible d'origine est dimensionné selon le voltage le plus courant dans le pays de destination.

ATTENTION – Déconnecter de l'alimentation avant l'opération.

1. Localiser le module d'entrée d'alimentation sur le panneau arrière.
2. Avec un petit tournevis, enlever le support à fusible en utilisant l'encoche au sommet du module d'entrée d'alimentation (voir le schéma ci-dessous).



3. Enlever le fusible du support comme montré ci-dessus.
4. Pour remise en état, sélectionner le fusible approprié et le placer sur le support.

Numero du Composant	Type
1800-7789	3A 250V Fusible temporisé

5. Réinstaller le support de fusible dans le module d'entrée d'alimentation.